ATTACHMENT E1

ATTACHMENT E-1

HYDROGEOLOGIC REPORT

DETREX CORPORATION

GOLD SHIELD SOLVENTS

GRAND RAPIDS MICHIGAN

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1.0 INTRODUCTION

In November 1988, CRA submitted, on the behalf of Detrex, an Act 64 Operating License Application for the Gold Shield solvents facility to the Michigan Department of Natural Resources (MDNR). In April 1989, the MDNR completed a review of the operating license application and determined that a hydrogeologic report was necessary.

In May 1989, Conestoga-Rovers and Associates (CRA), on behalf of Detrex Corporation (Detrex), conducted a hydrogeological investigation for the Gold Shield Solvents facility (facility) located at 312 Ellsworth Avenue in Grand Rapids, Michigan. Figure 1.1 locates the facility and Figure 1.2 presents a facility plan.

The requirements of the hydrogeologic investigation are specified in Act 64, Rule 229.9506(1) and (2). During the active drilling program, communication with the MDNR (via telephone conversations) confirmed the requirements of the hydrogeologic investigation field activities, this included the instrumentation of only one deep well and a minimum of three soil borings at the site (due to the size of the facility, approximately 0.4 acres). In total, one deep well, two shallow wells and one soil boring were completed.

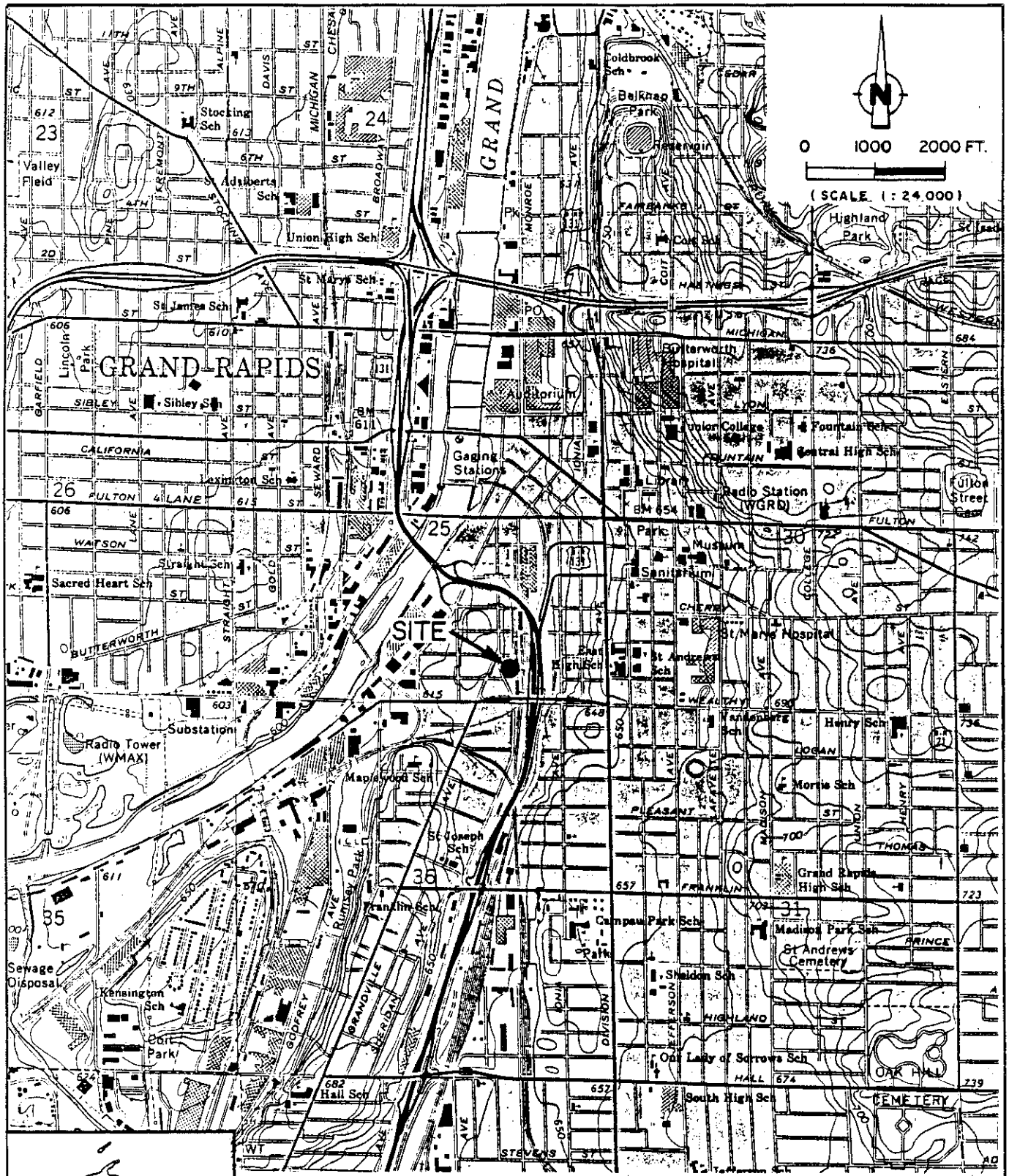

figure 1.1
SITE LOCATION
Detrex Corporation
Gold Shield Solvents, Grand Rapids

CRA

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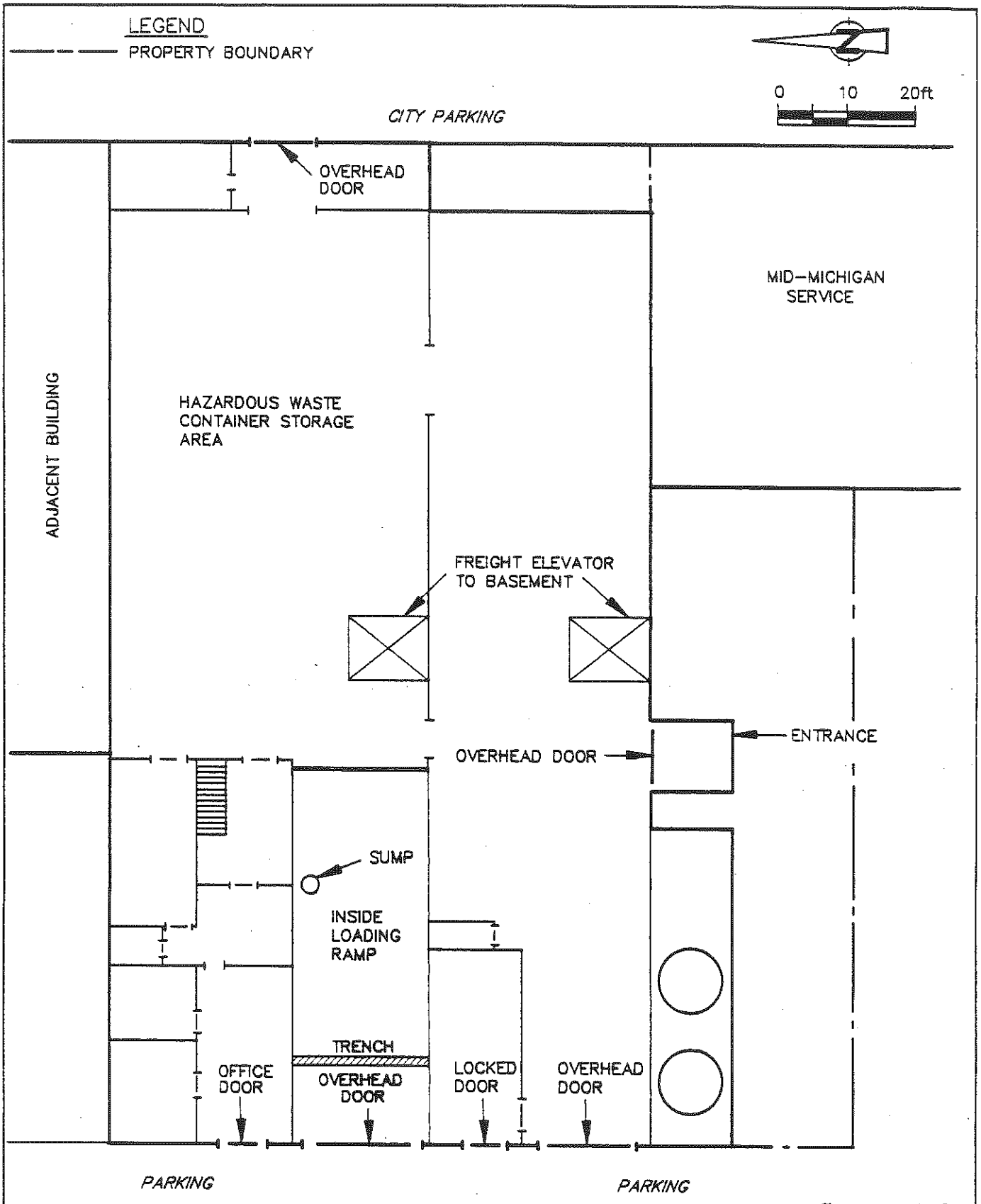


figure 1.2

FACILITY PLAN
Detrex Corporation
Gold Shield Solvents, Grand Rapids

CRA

2471-4/11/88-6-D-1

1.1 OBJECTIVES

The objectives of the hydrogeologic investigation were as follows:

1. identify the uppermost aquifer and aquifers hydraulically interconnected to the uppermost aquifer beneath the facility property; and

2. define soil and groundwater conditions beneath the facility which includes the geotechnical and hydraulic properties of the subsurface geology.

This report presents all pertinent information required under Act 64, Rule 299,9506(1) and discusses the field activities and results of the hydrogeological investigation pursuant to Act 64, Rule 299,9506(2).

2.0 FIELD ACTIVITIES

CRA conducted a hydrogeologic investigation during the weeks of May 1, 1989 and May 8, 1989. Three monitoring wells were installed and one borehole was advanced to determine geologic and hydrogeologic characteristics. CRA contracted Sterns Drilling Company of Dutton, Michigan, to perform the required drilling.

Following is a description of all field activities as conducted during this investigation.

2.1 MONITORING WELL INSTALLATION

Three monitoring wells were installed, one each on the east, southwest and north sides of the facility. A fourth borehole was advanced for the purpose of installing a monitoring well, however, groundwater was not encountered at completed depth of 40 feet below ground surface and the borehole was sealed. The wells and borehole are located on Figure 2.1. Table 2.1 summarizes well completion details. All drilling was performed with a CME 55 drill rig.

All three wells were constructed with a 10-inch diameter PVC outer casing advanced two feet into a shallow clay till unit. This casing

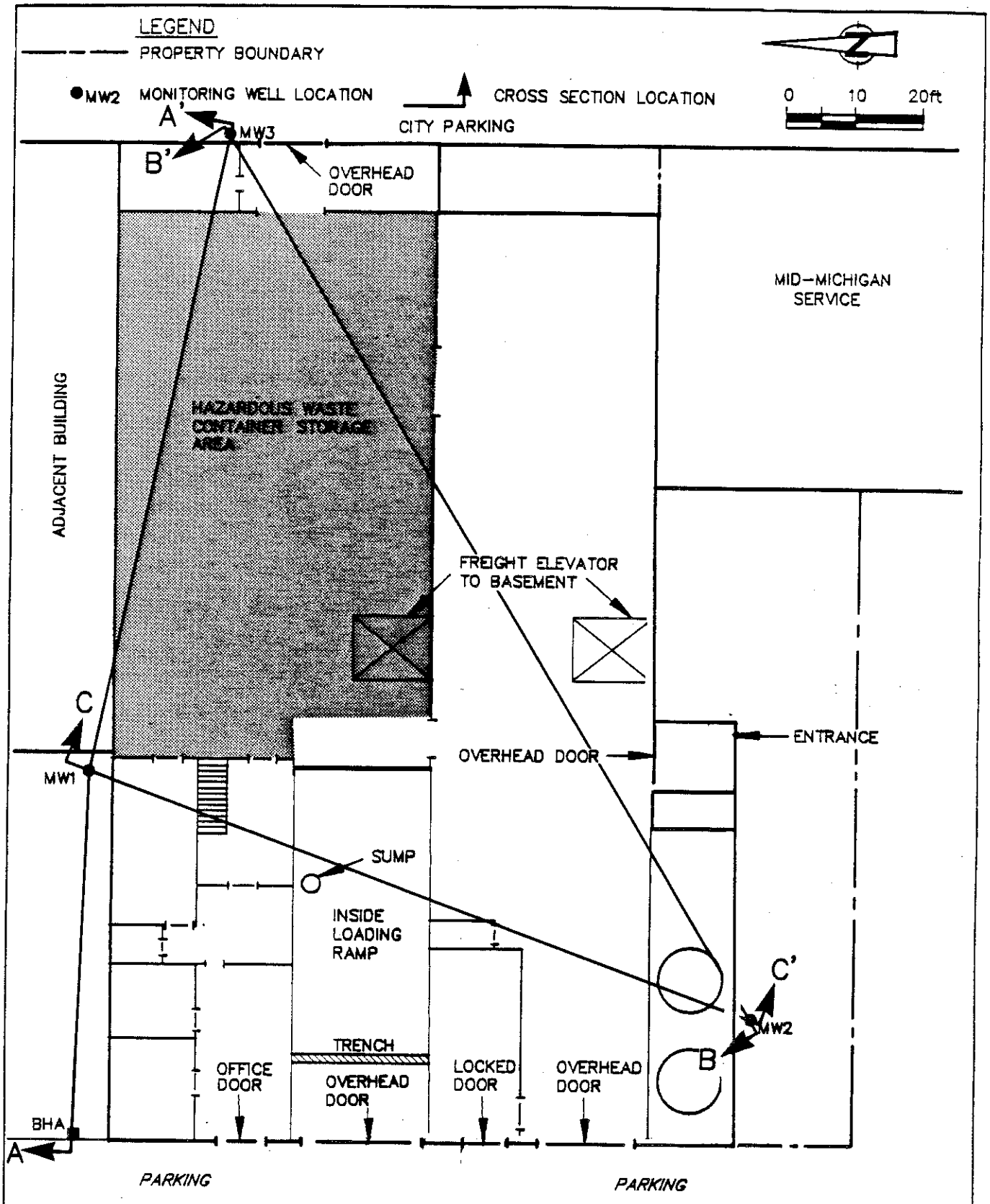


figure 2.1

MONITORING WELL LOCATIONS

Detrex Corporation

Gold Shield Solvents, Grand Rapids

CRA

2471-4/11/88-6-D-1

TABLE 2.1

WELL COMPLETION DETAILS

Well #	*Date Completed*	*Ground Elevation (ft. AMSL)*	*Top of Casing Elevation (ft. AMSL)*	*Screened Elevation (ft. AMSL)*		*Sand Pack Interval (ft. AMSL)*		*May 12, 1989 Groundwater Elevation (ft. AMSL)*
MW1	5-5-89	623.3	622.99	553.3	563.3	551.3	573.3	595.64
MW2	5-8-89	626.7	626.38	586.7	601.7	586.7	603.7	600.09
MW3	5-10-89	621.7	621.37	597.7	602.7	597.7	605.2	600.23
BHA	5-9-89	627.9	--	--	--	--	--	--

was installed using a 14 1/4 inch O.D. hollow stem auger. The 10-inch diameter PVC casing was then sealed in place with bentonite grout.

It was intended to use a 14 1/4 inch I.D. hollow stem auger to continue drilling inside the 10-inch diameter PVC casing, however, difficulties were encountered with the auger "binding" and "tearing free" the outer casing. To compensate this problem, wet rotary methods were used to drill at monitoring well locations MW1 and MW3.

The 10-inch outer diameter PVC casing at MW1, was installed to a depth of 5.5 feet below ground surface. The borehole was further advanced using a 3 7/8 inch tricone drilling bit. Continuous soil samples were collected to 40-feet below ground surface, using precleaned 2-inch diameter stainless steel split spoons. From 40 feet to 72 feet split-spoon soil samples were collected at 5-foot intervals.

The 10-inch diameter outer PVC casing at MW2, was installed to a depth of 8.5 feet below ground surface. Drilling was further completed using a 4 1/4 inch I.D. hollow stem auger. Continuous split-spoon soil sampling was completed to 32 feet below ground surface. From 32 feet to 40 feet split-spoon soil sampling was completed at 5-foot intervals.

The 10-inch diameter outer PVC casing at MW3, was advanced to a depth of 12.5 feet below ground surface. Drilling was completed

using a 3 7/8 inch tricone bit. Continuous split-spoon soil sampling was completed to 36 feet below ground surface.

All monitoring wells were constructed using continuous slot, stainless steel, Johnson well screens and 2-inch diameter flush mounted, galvanized steel riser. A quartz sand pack (20 frac) was placed around and to a minimum of 2 feet above the well screens. A 2-foot to 3-foot seal was placed over the sand using Benseal™ bentonite compound. The remaining annulus was tremie grouted to the surface with bentonite/cement grout. The wells were completed below grade with a lockable cap and flush mounted protective casing.

A 10-inch diameter outer PVC casing at BHA, was installed to a depth of 7.5 feet below ground surface. Drilling was further completed using a 4 1/4 inch I.D. hollow stem auger. Continuous split-spoon soil sampling was completed to 30 feet below ground surface. From 30 feet to 40 feet, split-spoon soil samples were taken at 5-foot intervals. No water was encountered to completed depth, thus the borehole was backfilled with bentonite/cement grout to the surface.

Stratigraphic and instrumentation logs for the monitoring wells and the borehole are provided in Appendix A.

2.2 SOIL ANALYSIS

2.2.1 Geotechnical Analyses

Soil samples were collected using pre-cleaned stainless steel split spoons. Soil samples for grain size distribution, Atterberg limits and moisture content analysis were collected from all boring locations. Shelby tube samples were collected from BHA, for permeability analysis.

Soil laboratory analyses was completed by Dell Engineering of Holland, Michigan.

Table 2.2 lists the soil samples collected, their location, depth and analysis performed. The resulting lab analysis reports are presented in Appendix B.

2.2.2 Chemical Analyses

During the installation of well MW2, a strong petroleum odor was observed at the top of the groundwater of the uppermost aquifer (see Section 3.0). Split-spoon soil samples were subsequently selected for the chemical analyses of Target Compound List (TCL) volatile organic compounds (VOCs) and Total Petroleum Hydrocarbons (TPH). The four

TABLE 2.2

SOIL SAMPLE DISTRIBUTION

Well Location	*Sample Number*	*Sample Depth (ft. BGS)*	*Geologic Unit*	*Analytical Parameters*
MW1	SS1	.5-2	Fill	Grain size
	SS2	2-4	Fill/Upper Till	Atterberg Limit
	SS3	4-6	Upper Till	Grain Size
	SS4	6-8	Upper Till	Atterberg Limit
	SS5	8-10	Upper Till/Alluvium	Grain Size
	SS6	10-12	Alluvium	Grain Size
	SS7	12-14	Alluvium	Moisture Content
	SS8	14-16	Alluvium	
	SS9	16-18	Lower Till	
	SS10	18-20	Lower Till	Atterberg Limit
	SS11	22-24	Lower Till	Moisture Content
	SS12	24-26	Lower Till	Grain Size
	SS13	26-28	Lower Till	Grain Size
	SS14	28-30	Lower Till	
	SS15	30-32	Lower Till	
	SS16	32-34	Lower Till	Grain Size
	SS17	34-36	Lower Till	
	SS18	36-38	Lower Till	Moisture Content
	SS19	38-40	Lower Till	
	SS20	43-45	Lower Till	
	SS21	48-50	Bedrock Transition	
	SS22	50-52	Bedrock Transition	
	SS23	53-55	Bedrock Transition	
	SS24	58-60	Bedrock Transition	
	SS25	60-62	Bedrock	
	SS26	63-65	Bedrock	
	SS27	66-68	Bedrock	
MW2	SS1	8.0-10.0	Upper Till	Grain Size
	SS2	10-12.0	Upper Till	Atterberg Limit
	SS3	12.0-14.0	Upper Till	Moisture Content
	SS4	14.0-16.0	Upper Till Alluvium	
	SS5	16.0-18.0	Alluvium	
	SS6	18.0-20.0	Alluvium	
	SS7	20.0-22.0	Alluvium	Grain Size
	SS8	22.0-24.0	Alluvium	
	SS9	26.0-28.0	Alluvium	Moisture Content
	SS10	26.0-28.0	Alluvium (Duplicate)	TCL VOC, TPH
	SS11	28.0-30.0	Alluvium	TCL VOC, TPH

TABLE 2.2

SOIL SAMPLE DISTRIBUTION

Monitoring Well	*Sample Number*	*Sample Depth (ft. BGS)*	*Geologic Unit*	*Analytical Parameters*
MW2(cont'd)	SS12	30.0-32.0	Alluvium	TCL VOC, TPH
	SS13	33.0-35.0	Alluvium	TCL VOC, TPH
	SS14	38.0-40.0	Lower Till	Atterberg Limit
MW3	SS1	0-2	Fill	
	SS2	2-4	Fill	
	SS3	4-6	Fill	Grain Size
	SS4	6-8	Fill	Atterberg Limit
	SS5	8-10	Fill	Moisture Content
	SS6	10-12	Upper Till	
	SS7	12-14	Upper Till	
	SS8	14-16	Upper Till	
	SS9	16-18	Upper Till/Alluvium	
	SS10	18-20	Alluvium	Grain Size
	SS11	20-22	Alluvium/Lower Till	Grain Size
	SS12	22-24	Lower Till	
	SS13	24-26	Lower Till	
	SS14	26-28	Lower Till	Grain Size
	SS15	28-30	Lower Till	Attergerg Limit
	SS16	30-32	Lower Till	Moisture Content
	SS17	32-34	Lower Till	
	SS18	34-36	Lower Till	
BHA	ST1	8.0-10.0	Upper Till	NA
	SS2	10.0-12.0	Alluvium	Grain Size
	SS3S	14.0-16.0	Alluvium	
	SS3C	14.0-16.0	Lower Till	Attergerg Limit
	ST4	18.0-20.0	Lower Till	Permeability
	SS5	20.0-22.0	Lower Till	
	SS6	22.0-24.0	Lower Till	Grain Size
	SS7	24.0-26.0	Lower Till	Atterberg Limit
	ST8	26.0-28.0	Lower Till	Permeability
	SS9	28.0-30.0	Lower Till	Moisture Content
	SS10	33.0-35.0	Lower Till	
	SS11	38.0-40.0	Lower Till	

Notes: SS = Split-Spoon Sample
ST = Shelby Tube Sample
TCL VOC = Target Compound List Volatile Organic Compounds
TPH = Total Petroleum Hycrocarbons

samples were collected across the full saturated thickness of the aquifer. Table 2.2 identifies the soil sample locations.

The chemical analyses were conducted by Wadsworth Alert Laboratories, Inc. of North Canton, Ohio. The final laboratory analyses reports are presented in Appendix C.

2.3 EQUIPMENT CLEANING

Between boreholes, all augers, drill rod, well materials, split spoons and other appropriate equipment were cleaned with a high temperature low volume, hot water steam wash.

2.4 WELL DEVELOPMENT

All monitoring wells were developed using pre-cleaned stainless steel bailers. A minimum of ten standing well volumes were removed from each well. Water quality, pH and conductivity were noted during development. All wells exhibited stable, pH and conductivity. Table 2.3 summarizes well development data.

TABLE 2.3

WELL DEVELOPMENT SUMMARY

Monitoring Well	*Well Volume*	*Date*	*Cumulative Gallons Removed*	*Water Clarity*	*pH*	*Conductivity*	*Water Level*	*Development Method*
MW1	7.2	5-8-89	5.0	Clear			27.03	Bailer
			15.0	Clear	6.8	1,000		Bailer
			30.0	Clear	6.7	1,000	28.11	Bailer
			40.0	Clear	6.9	900		Bailer
		5-12-89	50.0	Clear	6.7	1,000	27.35	Bailer
			60.0	Clear	6.7	1,100		Bailer
			70.0	Clear	6.8	1,000		Bailer
			80.0	Clear	6.8	1,100	27.35	bailer
MW2	2.20	5-8-89	10.0	Silty, Brown Chemical Odor	6.7	2,400	26.22	Bailer
			20.0	Silty Brown Chemical Odor	6.4	2,300	26.22	Bailer
		5-9-89	25.0	Silty, Brown Chemical Odor	6.5	2,600	26.25	Bailer
			30.0	Silty, Brown Chemical Odor	6.5	2,600	26.25	Bailer
			35.0	Silty, Brown Chemical Odor	6.5	2,600	26.25	Bailer

TABLE 2.3

WELL DEVELOPMENT SUMMARY

Monitoring Well	*Well Volume*	*Date*	*Cumulative Gallons Removed*	*Water Clarity*	*pH*	*Conductivity*	*Water Level*	*Development Method*
MW3	0.47	5-11-89	5.0	Slightly Cloudy	11.0	1,600	23.12	Bailer
			10.0	Slightly Cloudy	10.6	1,200	23.5	Bailer
			15.0	Slightly Cloudy	10.9	1,200	23.1	Bailer
			17.5	Slightly Cloudy	10.8	1,200	21.92	Bailer
			20.0	Slightly Cloudy	10.9	1,200	22.19	Bailer

2.5 HYDRAULIC RESPONSE TESTING

After well development, single well response tests were performed to determine hydraulic conductivity of the aquifers at their respective well screens.

A single well response test typically includes a falling and rising head test. The falling head test involves the introduction of a pre-cleaned slug, of known volume, into the well with subsequent monitoring of a declining water level with time. After the well stabilizes, the slug is removed causing the water level to instantaneously drop. The rising water level is subsequently monitored until the well stabilizes.

A single well response test, including both the falling and rising head test, was completed at bedrock well MW1. The data were analyzed by the method described by Hvorslev 1951. Appendix D presents the data and subsequent graph.

A single well response test was attempted at well MW2, however, no measurable water level was recorded with the introduction of the slug, thus the test was abandoned. A single well response test was not attempted at well MW3 due to insufficient water in the well.

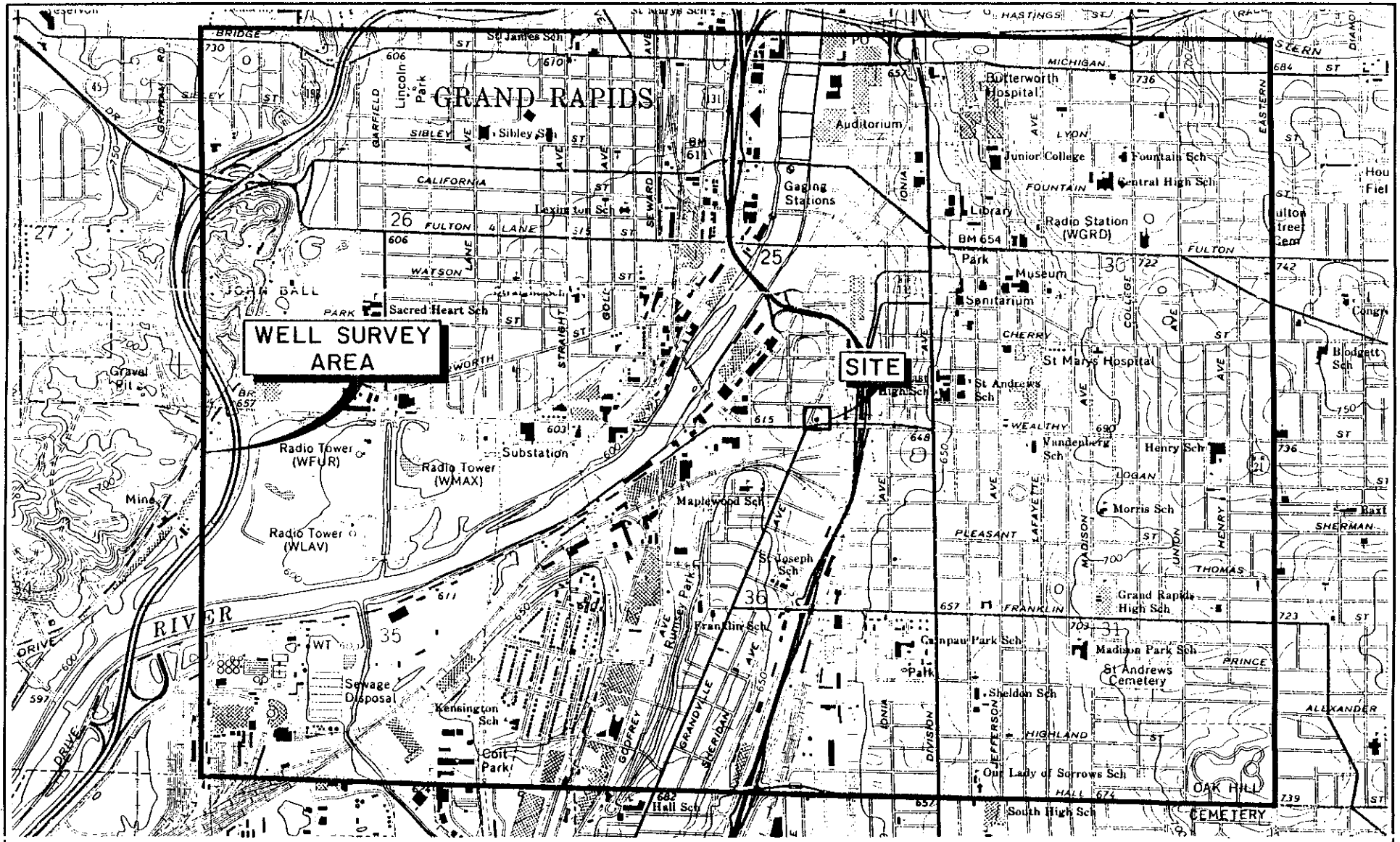
2.6 SITE SURVEY

A survey of well elevations, well locations and surrounding area was completed by W and W Engineering of Grand Rapids, Michigan, during the week of May 15, 1989. Included in this survey were: well elevations (ground and top of casing), site property boundaries, easement locations, topographical contours and cultural features located within 125 feet of the facility. All elevations were corrected to U.S.G.S. datum.

2.7 WELL SURVEY

A well survey was conducted within the following area: Sections 30 and 31, Township 7 North, Range 12 West, Kent County, Michigan. Figure 2.2 outlines the area.

The survey was conducted during the week of May 8, 1989, by the Michigan Department of Natural Resources, Geological Survey division. A list of the wells located in the above outlined area which includes partial descriptions of geology, well location and use, is located in Appendix E.



SCALE: 1" = 2000'

figure 2.2

WELL SURVEY AREA

Detrex Corporation

Gold Shield Solvents, Grand Rapids

CRA

2471-19/C 9-6-0

3.0 INTRODUCTION

3.1 GEOLOGY

The Western Michigan region, in which the Gold Shield solvent site is located, was glaciated several times during the Pliestocene epoch. The events of the most recent glacial episode termed the Wisconsin period, has had the most pronounced influenced on the region's physiography and surficial geology.

During the latter part of the Wisconsin period, glacial ice advanced over the Site region from both the west and east. The ice margins or lobes terminated in the Grand Rapids area depositing a mantle of material termed till. The resulting land forms, termed moraines, are evidenced in the area as regions of higher relief, hummocky terrain, and characteristic unconsolidated poorly sorted clay through gravel sized sediment.

Following glacial ice retreat, a large drainage system developed to channel away glacial meltwater and the waters of the pro-glacial Great Lakes. This drainage system is referred to as the Glacial Grand Valley which has a complex history of depositional and erosional events related to the advance and retreat of late stage Wisconsin period glaciers.

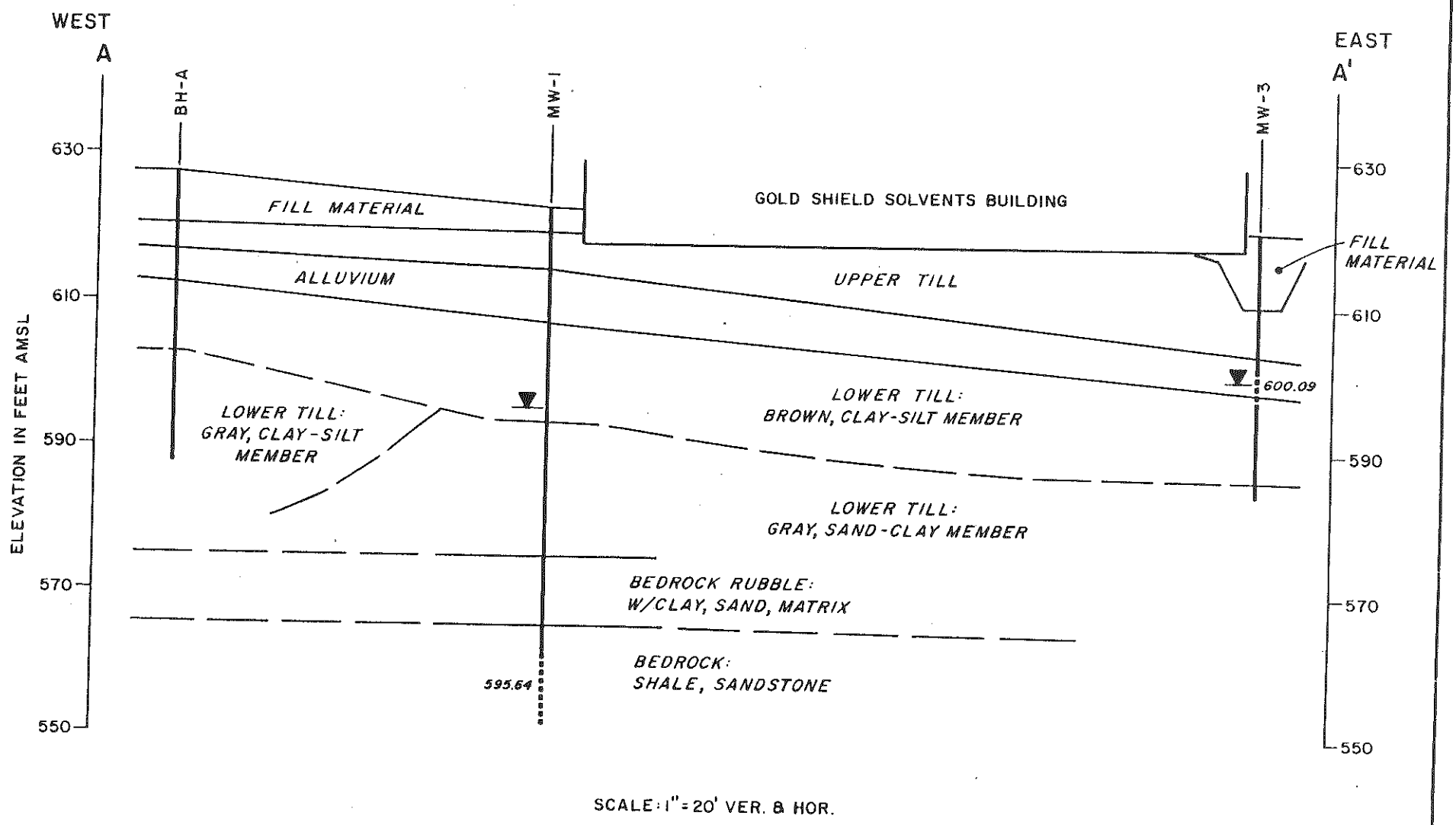
The Gold Shield Solvent Site is situated within the Glacial Grand River Valley approximately 1,600 feet east of the present Grand River.

The elevation of the river is approximately 585 feet, and the site approximately 625 feet. At this point, the Glacial Grand Valley is two miles wide. Elevations rise to 700 feet on the flanks of the valley. Several terrace features are noted on the Grand Rapids West 7.5' quadrangle. Most notably are terraces situated at 650 foot elevation located south and east of the Site. The subject site is located on the southeast end of a terrace like feature.

Underlaying the site is bedrock of the Mississippian Michigan formation, which consists of layered shale, dolomite limestone and sandstone.

Three monitoring wells and one borehole were advanced during this investigation for the purpose of determining site geologic and hydrogeologic characteristics. The findings revealed four overburden units. Bedrock was encountered in monitoring well #1 (MW1). Two groundwater systems were intercepted, a shallow/perched aquifer, and a deeper bedrock aquifer.

Figures 3.1, 3.2 and 3.3 are representative geologic cross sections across the Site. Figure 2.1, presented previously, shows the cross-section locations. The geologic units encountered at the Site are subsequently discussed.



SCALE: 1" = 20' VER. & HOR.

figure 3.1

GEOLOGIC CROSS-SECTION A-A'

Detrex Corporation

Gold Shield Solvents, Grand Rapids

CRA

2471-19/06/89-6-0

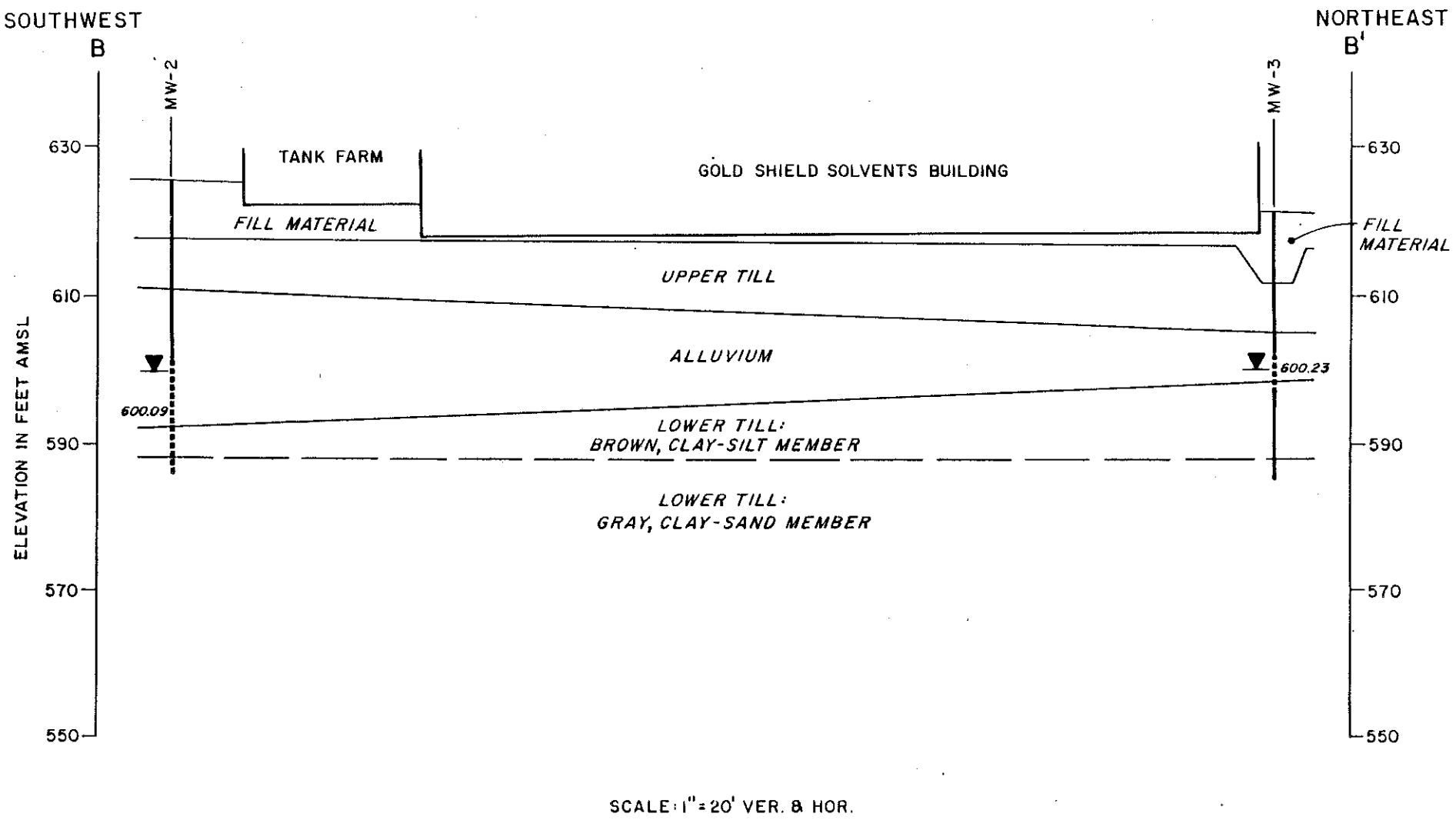


figure 3.2

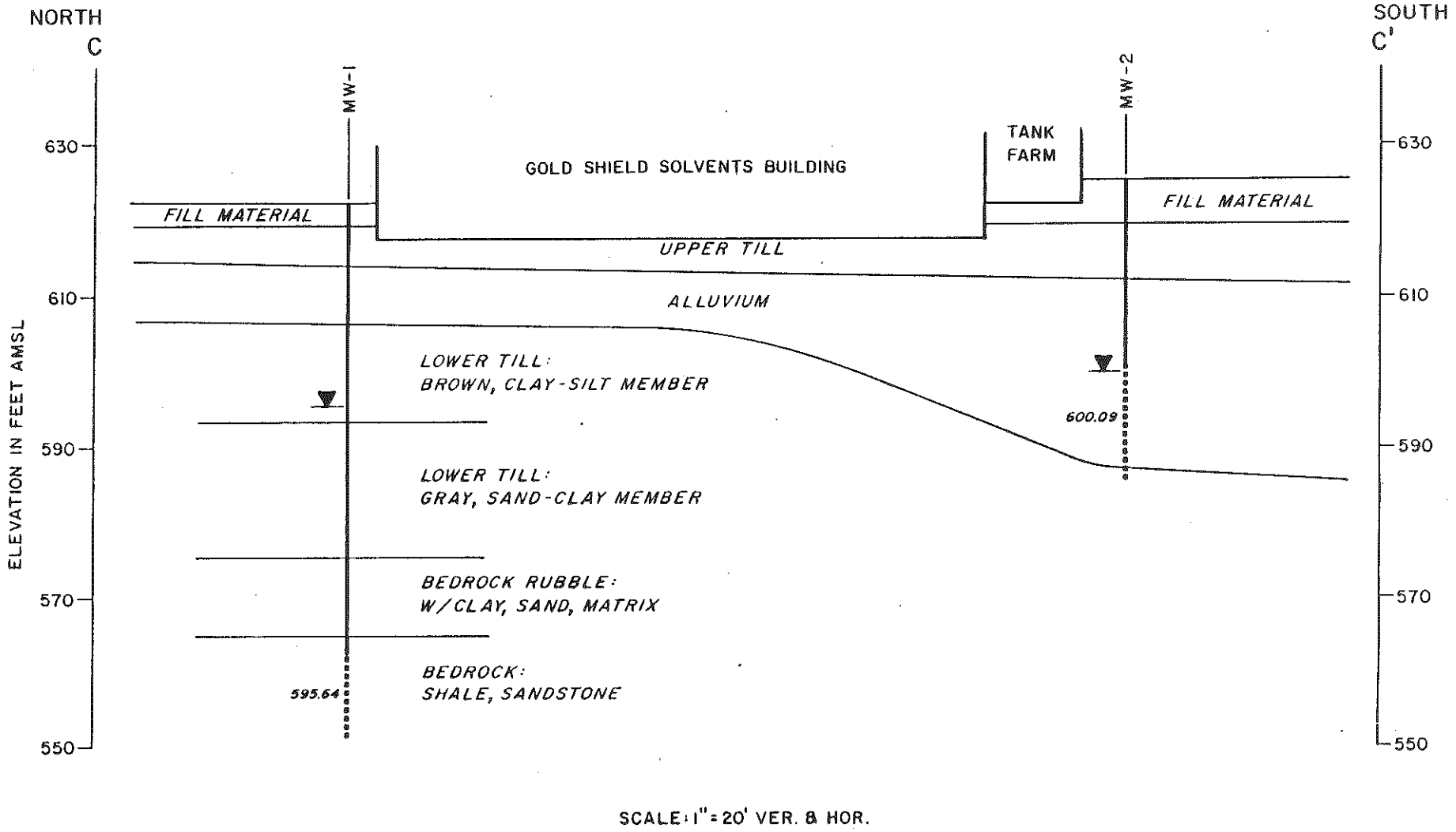
GEOLOGIC CROSS-SECTION B-B'

Detrex Corporation

Gold Shield Solvents, Grand Rapids

CRA

2471-19/ '89-6-0



SCALE: 1" = 20' VER. & HOR.

figure 3.3

GEOLOGIC CROSS-SECTION C-C'

Detrex Corporation

Gold Shield Solvents, Grand Rapids

CRA

2471-19/06/89-6-0

Fill Material

The uppermost overburden unit is composed of fill material. This material consists of fine to medium sand with trace to abundant clay and silt. The thickness of this unit varies from a depth of two feet to ten feet. It should be noted that fill material is thickest at MW3 where a trench has been previously excavated and backfilled.

Upper Till

The second overburden unit is termed the Upper Till, which is described as a reddish-brown, clay-silt till containing trace sand and gravel. The thickness of this unit ranges from five feet to eight feet.

Alluvium

Underlaying the Upper Till is a unit of sand and gravel alluvial material. This unit consists of tan, medium to coarse sand and fine to medium gravel. Sand is more abundant towards the upper portion and gravel is more abundant towards the lower portion. This unit ranges in thickness from 23.5 feet in MW2 to four feet in MW3. Groundwater was encountered in MW2 and MW3. Groundwater was not encountered in this unit at MW1 and BHA.

Lower Till

Underlaying the Alluvium material is a unit termed the Lower Till. This till consists of three members, the brown clay-silt member, the gray clay-sand member and the gray clay-silt member. All three members are poorly sorted and contain trace gravel-clasts.

Bedrock

Bedrock was encountered in MW1 at approximately 60 feet below ground surface. A layer with clay, silt and sand matrix surrounding bedrock rubble material was encountered at 48 feet below ground surface. Shale, siltstone, sandstone and gypsum fragments were recovered from this rubble "transition zone". Siltstone and shale was abundant from 60 feet below ground surface to the bottom of the borehole at 72 feet below ground surface. These rock types are characteristic of the Mississippian, Michigan formation.

Groundwater was encountered at approximately 58 feet below ground surface (565 feet AMSL) in a sandy zone within the bedrock rubble.

3.2 HYDROGEOLOGY

Two hydrogeologic units were encountered during this investigation; a shallow system located within the alluvial sand and gravel, and a deeper bedrock system. The two aquifers are separated by the lower till unit which is non-water bearing and considered a confining layer or aquitard.

Alluvial Aquifer Characteristics

The upper water bearing zone located within the alluvial unit is classified as an unconfined "perched" aquifer. Aquifers of this type typically are recharged by precipitation infiltration and are subject to frequent water level change. Groundwater flow direction could not be determined within the scope of this study due to the limited number of wells installed; however, it is reasonable to assume that flow direction follows the slope of the underlying aquitard topography and surface topography. As such, groundwater flow direction, in the alluvial aquifer, is assumed to be the west-southwest. The alluvial aquifer is considered the uppermost aquifer beneath the facility property.

As discussed in Section 2.5, single well response tests were not performed on the two wells completed within the alluvial aquifer. The hydraulic conductivity (K) within the alluvial aquifer was, therefore, estimated from the grain size distribution curve by utilizing the Hazen Method. This method was developed for clean sands where the effective

grain size (D_{10}) is between approximately 1.0 and 3.0 millimeters. However, this method is often used to estimate the hydraulic conductivity of most sand and silty sand mixtures. The Hazen Method is shown by:

$$K = (D_{10})^2$$

where

K is hydraulic conductivity in cm/sec.

D_{10} is the effective grain size in cm at 10 percent finer than

Using the Hazen Method, the hydraulic conductivity was estimated for the alluvial sands and gravels encountered in each monitoring well. Table 3.1 summarizes the interpreted grain size data and hydraulic conductivities estimated. Using the Hazen Method, the average hydraulic conductivity within the alluvial aquifer is estimated at 2.7×10^{-4} cm/sec.

Lower Till Aquitard Characteristics

Separating the upper and lower groundwater systems is the lower till confining layer. Two flexible wall permeability tests were conducted on samples collected from the lower till unit in BHA; one in the brown clay silt member, and one in the gray clay-silt member. The average stabilized permeability in the brown clay silt member was 1.99×10^{-8} cm/sec, and in the gray clay-silt member was 6.16×10^{-9} cm/sec. Grain size and Atterburg analysis results further indicate that this unit acts as a highly impermeable layer.

TABLE 3.1

SUMMARY OF ALLUVIUM PERMEABILITY VALUES DETERMINED USING THE HAZEN METHOD

Well Number	*Sample Number*	*Sample Depth*	*% Silt & Clay*	D_{10} *(cm)*	*K (cm/s)*
MW1	SS6	10' - 12'	15.1	0.015	2.3×10^{-4}
MW2	SS7	20' - 22'	13.9	0.019	3.6×10^{-4}
MW3	SS10	18' - 20'	2.2	0.015	2.3×10^{-4}
				Average	**2.7×10^{-4}**

Bedrock Aquifer Characteristics

The water bearing zone in the upper bedrock is considered to be a confined aquifer. The potentiometric surface in the bedrock well MW1 is at an elevation of 595.64 feet AMSL, approximately 30 feet above the top of the bedrock. Due to the impermeable characteristics and continuity of the overlying lower till unit, this aquifer is not considered to be hydraulically interconnected to the uppermost aquifer.

The average hydraulic conductivity of the bedrock aquifer at the well screen was determined, by the single well response test, to be 2.5×10^{-4} cm/sec (see Appendix D).

3.3 CHEMICAL DATA

3.3.1 General

The four soil samples collected from MW2 were analyzed for the TCL VOCs following SW846 Method 8240 Third Edition and for TPH using SW846 Method 8015 (modified). The laboratory analysis reports are presented in Appendix C.

Conestoga-Rovers & Associates (CRA) performed an independent data quality assessment and validation for the four soil samples. The data was reviewed for holding time periods, method blank samples, surrogate compounds percent recoveries (surrogate recoveries) and matrix spike/matrix spike duplicate recoveries. Based on CRA's review of the data, both the VOC and TPH results were found to be acceptable without any qualifications. The data may, therefore, be used as a quantitative measure of the soil contamination of the alluvial sands and gravels in the location of well MW2.

Table 3.2 summarizes the data for the soil samples.

3.3.2 Data Summary

A total of seven VOC parameters and TPH were detected in the soil samples. The VOCs detected include 1,2-dichloroethene, 1,1,1-trichloroethane, trichloroethylene, tetrachloroethene, toluene, ethylbenzene and total xylenes. Of the seven VOCs detected, only three parameters 1,1,1-trichloroethane, trichloroethylene and tetrachloroethene (perchloroethylene) are hazardous waste constituents handled at the Gold Shield Solvents Grand Rapids facility. Three of the remaining VOCs detected include toluene, ethylbenzene and total xylenes which are commonly associated with petroleum products, as is evidenced by the TPH data. It is to

TABLE 3.2

ANALYTICAL SOIL DATA (MW2)
SUMMARY OF DETECTED COMPOUNDS

Parameter	*Sample I.D. (Depth)* *SS10* (26.0-28.0 Ft.)	*SS11* (28.0-30.0 Ft.)	*SS12* (30.0-32.0 Ft.)	*SS13* (33.0-35.0 Ft.)
Volatile Organics (mg/kg)				
1,2-Dichloroethene (total)	2	4	ND1	ND1
1,1,1-Trichloroethane	1	3	ND1	ND1
Trichloroethylene	2	8	2	3
Tetrachloroethene	1	4	ND1	ND1
Toluene	4	8	ND1	ND1
Ethylbenzene	4	8	1	ND1
Total Xylenes	20	41	7	ND1
Total Petroleum Hydrocarbons (mg/kg)	98	200	36	ND10

Note:

NDx = Not detected at detection limit X

be noted that well MW2 was completed on the south side of the Gold Shield Solvents facility, adjacent to Mid-Michigan Services (service station).

All VOC parameters were detected at relatively low concentrations (equal to or less than 8 mg/kg) with the exception of total xylenes at 41 mg/kg at a depth of 28.0 - 30.0 feet below ground surface. TPH was also detected at a maximum concentration of 200 mg/kg at a depth of 28.0 - 30.0 feet below ground surface.

In general, the presence of toluene, ethylbenzene, total xylenes and TPH decreases with depth, with none of the parameters being detected at the maximum sample depth of 33.0 - 35.0 feet below ground surface. This condition is to be expected, since the specific gravity of petroleum products (i.e. gasoline, S.P. = 0.72 - 0.76; diesel fuel, S.P. < 0.876) is less than water (S.P. = 1.0). As such, these parameters are considered to be "floaters" and will not tend to migrate downwards.

The highest concentrations of the halogenated solvents were detected near the water level surface (trichloroethylene at 8 mg/kg). The concentrations of the halogenated solvents decreased with depth, such that only trichloroethylene was detected at depth at 3 mg/kg. Thus, although the specific gravity of these parameters are greater than water, the downward migration of these parameters at MW2 is somewhat limited.

As discussed in Section K of this operating permit application, a site investigation was recently completed by Detrex at its Gold Shield Solvents facility in Grand Rapids, Michigan. The site investigation was conducted under an approved MDNR work plan, to investigate the extent and degree of potential soil contamination at the facility. A copy of the final report for the site investigation is included in Section K of this operating license application.

As discussed in the site investigation report, a total of 39 soil samples from 13 boreholes were collected and analyzed for the same parameter's as discussed above (i.e. TCL VOCs and TPH). Ten boreholes were completed at locations adjacent to the Gold Shield Solvents facility, and were advanced into the top of the upper till unit (identified as lower till unit in site investigation report based on information available at time of the report). Three additional borings were completed at locations through the basement floor within the facility building. These boreholes were also advanced into the upper till unit.

The only constituents detected in the soil samples were trichloroethylene, 1,1,1-trichloroethane and TPH. The site investigation report concluded that the concentrations of trichloroethylene, 1,1,1-trichloroethane and TPH declined vertically through the overburden (fill material) to the overburden/clay (fill/upper till) interface. Although the results of the site investigation indicate that historic site activities may have impacted fill material adjacent to the site, the presence of contaminants in the

uppermost aquifer soils at MW2 may have resulted from off-site sources based to the following:

1) the absence of five of the VOCs in the overlying fill material compared to those VOCs detected in the soil samples in the saturated alluvium; and

2) the concentrations of trichloroethylene and 1,1,1-trichloroethane in the fill material at depth are less than the concentrations of trichloroethylene and 1,1,1-trichloroethane in the saturated alluvium.

4.0 CONCLUSIONS AND RECOMMENDATIONS

Based on the hydrogeologic investigation and the site investigation, the following conclusions are presented:

1) The site geology consists of, in descending order: fill material; upper clay till unit; sand and gravel alluvial material; lower clay till unit and bedrock.

2) The uppermost aquifer beneath the site is an unconfined alluvial aquifer encountered at approximately 25 to 35 feet below ground surface (600 feet AMSL). The hydraulic conductivity of the uppermost aquifer is estimated at 2.7×10^{-4} cm/sec.

3) A confined bedrock aquifer beneath the site, encountered at approximately 58 feet below ground surface (565 feet ASML), is not hydraulically interconnected to the uppermost aquifer beneath the Site due to the presence of a continuous, low permeability lower till unit between the two aquifers. The hydraulic conductivity of the lower till unit was calculated to be less than 2×10^{-8} cm/sec. The average hydraulic conductivity of the bedrock aquifer was calculated to be 2.5×10^{-4} cm/sec.

4) Trichloroethylene, 1,1,1-trichloroethane and TPH were identified in fill material on site and decline vertically through the fill material to the fill material/upper till unit interface.

5) Trichloroethylene, 1,1,1-trichloroethane, tetrachloroethene, 1,2-dichloroethene, toluene, ethylbenzene, total xylenes and TPH were identified in sands and gravels in the uppermost aquifer on site and decline vertically through the uppermost aquifer to the uppermost aquifer/lower till unit interface.

6) The presence of contaminants in the uppermost aquifer may have resulted from off-site sources.

Based on the conclusions presented above, it is recommended that a groundwater monitoring program be implemented to monitor the uppermost aquifer to determine whether historic activities at the site have impacted groundwater quality in the uppermost aquifer.

APPENDIX A

STRATIGRAPHIC AND INSTRUMENTATION LOGS

STRATIGRAPHIC AND INSTRUMENTATION LOG
(OVERBURDEN)

(L-4)

PROJECT NAME: DETREX – GOLD SHIELD SOLVENTS
HOLE DESIGNATION: MW1–89
(Page 1 of 2)
PROJECT NO.: 2471
DATE COMPLETED: MAY 5, 1989
CLIENT: DETREX
DRILLING METHOD: HSA/WR
LOCATION: GRAND RAPIDS, MICHIGAN
CRA SUPERVISOR: J. MICHELS

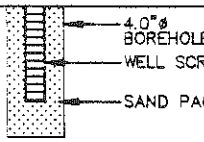
DEPTH ft BGS	STRATIGRAPHIC DESCRIPTION & REMARKS	ELEVATION ft AMSL	MONITOR INSTALLATION	SAMPLE NUMBER	SAMPLE STATE	SAMPLE 'N' VALUE
	GROUND SURFACE	623.3				
	REFERENCE ELEVATION (Top of Riser)	622.99	ROAD BOX	1SS		7
	SW(SAND)FILL, little silt, trace clay, trace gravel, reddish–brown, dry	620.3	CEMENT/ BENTONITE GROUT	2SS		5
5.0	CL(CLAY)TILL, silty, some sand, trace gravel, reddish–brown, slightly moist		10.0"ø SURFACE CASING (PVC) 15.0"ø BOREHOLE	3SS		6
				4SS		10
	SC(SAND)ALLUVIUM, clayey, trace gravel, brown, dry	614.8		5SS		17
10.0	SW(SAND), medium grained, little gravel, brown, moist	614.3	4.0"ø BOREHOLE	6SS		50
	GS(GRAVEL), sandy, little clay, gravel is pebble size	613.3		7SS		39
15.0	CL(CLAY)TILL, some silt, little sand, brown, moist	607.3		8SS		35
	Little–trace sand and gravel, gray, slightly moist			9SS		32
20.0		603.3		10SS		44
				11SS		53
				12SS		43
25.0				13SS		62
		595.6 ▼	2.0"ø GALVANIZED STEEL PIPE	14SS		67
	SC(SAND)TILL, clayey and silty, trace gravel, gray, slightly moist, very hard	594.3		15SS		52
30.0				16SS		63
				17SS		45
35.0	SP(SAND), little silt, trace clay, saturated	587.8		18SS		81
	SC(SAND), silty, little to some clay, trace gravel, gray, moist	587.3		19SS		45
	SP(SAND), little silt, gray, wet	584.3				
40.0						
	CL(CLAY)TILL, sandy, some silt, trace gravel, moist	580.3				
45.0				20SS		36
		575.3	BENTONITE PELLET SEAL			
	BR(GYPSUM), white, powdery, dry			21SS		100+
50.0		573.3		22SS		22
	CL(CLAY)TILL, silty, angular, clasts of limestone which was bedded, gray, moist oily material in drilling water					
55.0	ML(SILT), clayey, slightly fissile	570.3		23SS		103
	No recovery, drills like sand	565.3 ▽ 565.3				
60.0	BROKEN SANDSTONE AND SHALE, sandstone is brown, well cemented and occurs as a 4" bed, shale is clayey, fissile and contains scattered pyrite crystals, saturated zone	563.3	SAND PACK	24SS		51
				25SS		100+
		560.3				
65.0	CLAYEY SILTSTONE, fissile, shaley, bedded, weathered, gray, moist			26SS		100+
		457.3	WELL SCREEN			
	Clayey siltstone, interbedded with silty claystone, shaley			27SS		76

NOTES: MEASURING POINT ELEVATIONS MAY CHANGE; REFER TO CURRENT ELEVATION TABLE

GRAIN SIZE ANALYSIS (oval) WATER FOUND ▽ STATIC WATER LEVEL ▼ (05/12/89)

STRATIGRAPHIC AND INSTRUMENTATION LOG
(OVERBURDEN)

PROJECT NAME: DETREX – GOLD SHIELD SOLVENTS
HOLE DESIGNATION: MW1–89 (Page 2 of 2)
PROJECT NO.: 2471
DATE COMPLETED: MAY 5, 1989
CLIENT: DETREX
DRILLING METHOD: HSA/WR
LOCATION: GRAND RAPIDS, MICHIGAN
CRA SUPERVISOR: J. MICHELS

DEPTH ft BGS	STRATIGRAPHIC DESCRIPTION & REMARKS	ELEVATION ft AMSL	MONITOR INSTALLATION	SAMPLE NUMBER	SAMPLE STATE	SAMPLE RECOVERY
70.0	Clayey siltstone, interbedded with silty claystone, shaley			27SS	☒	76
	END OF HOLE @ 72.0 FT. BGS	*551.3*	SCREEN DETAILS: Screened Interval: 563.3' to 553.3' AMSL Length –10' Diameter –2" Slot # 7 Material – Stainless Steel Sand pack interval: 573.3' to 551.3' AMSL Material – Sand			
75.0						
80.0						
85.0						
90.0						
95.0						
100.0						
105.0						
110.0						
115.0						
120.0						
125.0						
130.0						

NOTES: MEASURING POINT ELEVATIONS MAY CHANGE; REFER TO CURRENT ELEVATION TABLE

GRAIN SIZE ANALYSIS ⬭ WATER FOUND ▽ STATIC WATER LEVEL ▼

STRATIGRAPHIC AND INSTRUMENTATION LOG
(OVERBURDEN)

(L-5)

PROJECT NAME: DETREX – GOLD SHIELD SOLVENTS
HOLE DESIGNATION: MW2–89

PROJECT NO.: 2471
DATE COMPLETED: MAY 8, 1989

CLIENT: DETREX
DRILLING METHOD: HSA

LOCATION: GRAND RAPIDS, MICHIGAN
CRA SUPERVISOR: J. MICHELS

DEPTH ft BGS	STRATIGRAPHIC DESCRIPTION & REMARKS	ELEVATION ft AMSL	MONITOR INSTALLATION	SAMPLE NUMBER	SAMPLE STATE	SAMPLE N VALUE
	GROUND SURFACE	626.7				
	REFERENCE ELEVATION (Top of Riser)	626.38	ROAD BOX			
	FILL		CEMENT/BENTONITE GROUT			
5.0			10.0"ø SURFACE CASING (PVC)			
		618.7	15.0"ø BOREHOLE			
10.0	CL(CLAY)TILL, silty, trace sand, slight plastic, brown, dry			1SS		40
				2SS		23
			4.75"ø BOREHOLE	3SS		31
15.0	SP(SAND)ALLUVIUM, fine to medium grained, trace gravel, clayey toward top, tan, slightly moist, loose	612.2		4SS		20
				5SS		16
	GP(GRAVEL), sandy, tan, moist, loose	607.7	2.0"ø GALVANIZED STEEL PIPE	6SS		22
20.0				7SS		37
	GC(GRAVEL), sandy, some clay, brownish–red, moist	604.7	BENTONITE PELLET SEAL	8SS		32
		602.7 ▽				
25.0	Saturated, strong petroleum/chemical odor	600.7				
		600.1 ▼		9SS		3
				10SS		
			SAND PACK	11SS		12
30.0	GC(GRAVEL) and SC(SAND), interbedded, tan, saturated, petro–chemical odor	596.7		12SS		15
	CL(CLAY) and SC(SAND), interbedded, clay is sandy, brown, moist, sand is coarse, contains trace gravel, brown, saturated	593.7	WELL SCREEN			
35.0				13SS		34
		588.7				
	CL(CLAY)TILL, some silt, trace gravel, plastic, gray, moist	586.7		14SS		26
40.0	END OF HOLE @ 40.0 FT. BGS					
45.0						
50.0						
55.0						
60.0						
65.0						

SCREEN DETAILS:
Screened Interval:
601.7' to 586.7' AMSL
Length – 15'
Diameter – 2"
Slot # 7
Material – Stainless Steel
Sand pack interval:
603.7' to 586.7' AMSL
Material – Sand

NOTES: MEASURING POINT ELEVATIONS MAY CHANGE; REFER TO CURRENT ELEVATION TABLE

GRAIN SIZE ANALYSIS ⬭ WATER FOUND ▽ STATIC WATER LEVEL ▼ (05/12/89)

STRATIGRAPHIC AND INSTRUMENTATION LOG
(OVERBURDEN)

(L-6)

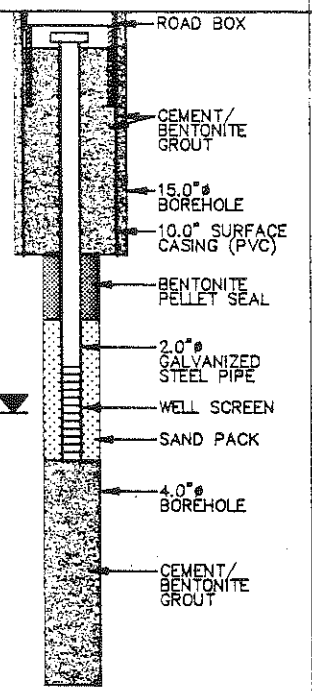
PROJECT NAME: DETREX – GOLD SHIELD SOLVENTS
HOLE DESIGNATION: MW3–89

PROJECT NO.: 2471
DATE COMPLETED: MAY 10, 1989

CLIENT: DETREX
DRILLING METHOD: HSA/WR

LOCATION: GRAND RAPIDS, MICHIGAN
CRA SUPERVISOR: J. MICHELS

DEPTH ft BGS	STRATIGRAPHIC DESCRIPTION & REMARKS	ELEVATION ft AMSL
	GROUND SURFACE	621.7
	REFERENCE ELEVATION (Top of Riser)	621.34
	SP(SAND)FILL, medium grained, roots, brown, dry	621.2
5.0	CL(CLAY)FILL, sandy, silty, trace gravel, brown and red, dry	619.7
	SP(SAND)FILL, medium grained, brown, dry	615.9
	SW(SAND)FILL, silty, some clay, cinders, black	615.7
10.0	SW(SAND)FILL, and CL(CLAY)FILL, silty, trace gravel, irregular occurrence of black organic material and wood, black, slightly moist	611.7
	CL(CLAY)FILL, silty, some sand, trace gravel, black, roots and wood, moist @ 8.0' BGS	
15.0	CL(CLAY)TILL, some little silt, trace sand, wood fragments, gray and bluish–green, plastic, slightly moist	
	Some silt, trace sand, mottled green and gray, reddish–brown toward bottom, slightly moist @ 16' BGS	604.0
20.0		600.2
	SP(SAND)ALLUVIUM, medium grained, reddish–brown, slightly moist, loose	
25.0	Tan, moist @ 18.0' BGS	
	CL(CLAY)TILL, silty, some sand, trace gravel, brown, slightly moist	
	Some silt, gray, dry	593.7
30.0		
	SC(SAND), clayey, brown, medium grained, wet	587.2
35.0		
	END OF HOLE @ 36.0 FT. BGS	585.7
40.0		
45.0		
50.0		
55.0		
60.0		
65.0		



SCREEN DETAILS:
Screened Interval:
602.7' to 597.7' AMSL
Length – 5'
Diameter – 2"
Slot # 7
Material – Stainless Steel
Sand pack interval:
605.2' to 597.7' AMSL
Material – Sand

SAMPLE NUMBER	STATE	'N' VALUE
1SS		2
2SS		2
3SS		10
4SS		9
5SS		16
6SS		13
7SS		9
8SS		13
9SS		23
10SS		17
11SS		26
12SS		46
13SS		38
14SS		28
15SS		22
16SS		16
17SS		19
18SS		6

NOTES: MEASURING POINT ELEVATIONS MAY CHANGE; REFER TO CURRENT ELEVATION TABLE

GRAIN SIZE ANALYSIS (oval) WATER FOUND ▽ STATIC WATER LEVEL ▼ (05/12/89)

STRATIGRAPHIC AND INSTRUMENTATION LOG
(OVERBURDEN)

(L-7)

PROJECT NAME: DETREX – GOLD SHIELD SOLVENTS
HOLE DESIGNATION: BHA–89

PROJECT NO.: 2471
DATE COMPLETED: MAY 9, 1989

CLIENT: DETREX
DRILLING METHOD: HSA

LOCATION: GRAND RAPIDS, MICHIGAN
CRA SUPERVISOR: J. MICHELS

DEPTH ft BGS	STRATIGRAPHIC DESCRIPTION & REMARKS	ELEVATION ft AMSL	MONITOR INSTALLATION	SAMPLE NUMBER	SAMPLE STATE	SAMPLE 'N' VALUE
	GROUND SURFACE	627.9				
3.0	FILL		CEMENT/BENTONITE GROUT; 15.0"ø BOREHOLE; 10.0"ø SURFACE CASING			
6.0						
9.0	CL(CLAY)TILL, silty, some little sand, brown, dry	619.9	CEMENT/BENTONITE GROUT	1ST		NA
12.0	GW(GRAVEL)ALLUVIUM, sandy, well graded, well rounded, clasts, tan, dry Attempted shelby, no recovery	617.9 615.9	4.75"ø BOREHOLE	2SS		26
15.0	CL(CLAY)TILL, sandy, silty toward 16' BGS, reddish–brown, slightly moist	612.9		3SS		38
18.0	Some silt, trace gravel, slight plastic, brown, olive green–gray, slightly moist Some silt, some gravel, greenish–brown, slightly moist	611.9 609.9		4ST		NA
21.0	Silty, trace gravel, gray, hard, dry, fractured vertically with iron oxide coatings on fractures	607.9		5SS		17
				6SS		22
24.0				7SS		62
27.0				8ST		NA
				9SS		50
30.0						
33.0				10SS		49
36.0						
39.0				11SS		55
	END OF HOLE @ 40.0 FT. BGS	587.9				

NOTES: MEASURING POINT ELEVATIONS MAY CHANGE; REFER TO CURRENT ELEVATION TABLE

GRAIN SIZE ANALYSIS (oval) WATER FOUND ▽ STATIC WATER LEVEL ▼

APPENDIX B

GEOTECHNICAL LABORATORY DATA REPORTS

DELL ENGINEERING, INC.
245 EAST LAKEWOOD BLVD.
HOLLAND, MI 49424-2066
PHONE 616-396-1296
FAX 616-396-7924

TRANSMITTAL

TO: Conestoga-Rovers & Associates, Inc.
382 West County Road D
St. Paul, Minnesota 55112

DATE: June 8, 1989

PROJECT: D.E. # 89300

JUN 09 89

ATTN: Jon Michels

WE ARE TRANSMITTING ✓ HEREWITH ____ UNDER SEPARATE COVER

QUANTITY	DESCRIPTION
One (1) copy	Grain Size Analysis and Flexible Wall Permeability Test results

ISSUED FOR ____ REVIEW & COMMENT ____ APPROVAL ____ INFORMATION
____ CONSTRUCTION ____ YOUR FILE ✓ AS REQUESTED

REMARKS

DISTRIBUTION

file

DELL ENGINEERING, INC.

BY: R. Joseph Trojan

R. Joseph Trojan
Geologist

FLEXIBLE WALL PERMEAMETER TESTS (Tentative ASTM Procedure)
(After: Soil Test, Flexible Wall Permeameter System Users Manual)

Flexible wall permeameters operate on a pressure differential established between burettes connected to the upper and lower cross-sectional area of a soil core sample. A soil sample extracted from a shelby tube is first encased in a Playtex sleeve. Porous disks, attached to a pressurized burette system, are placed on the open ends of this sleeve and the soil sample is subsequently placed in a plexiglas chamber. Water is fed into the chamber and a confining pressure of 30 psi is applied to the sample. A pressure differential of 15 psi is established across the soil sample by a applying a pressure of 5 psi to the upper disk and 20 psi to the lower disk. Following saturation of the sample, permeability is calculated by recording the rate that water flows into the upper burette and out of the lower burette (see accompanying diagram).

The following equations are used to calculate the permeability:

$$K = 0.5 \frac{(a_u + a_L)}{1+(a_u/a_L)} \cdot \frac{L_s}{A_s} \cdot \frac{1}{t_2-t_1} \ln \frac{h_{t1}}{h_{t2}}$$

Where, K = permeability
a_u = cross-sectional area of upper burette
a_L = cross-sectional area of lower burette
L_s = length of sample
A_s = cross-sectional area of sample
$t_{1,2}$ = time of readings
H_{t1}, h_{t2} = head at t_1 and t_2, respectively

The head is calculated from the burette readings by the following equation:

$$h = \frac{50 - V_L}{a_L} \approx \frac{50 - V_u}{a_u} + \frac{P_L - P_u}{\gamma_w}$$

Where, h = head
V_L = volume of water in the lower burette
V_u = volume of water in the upper burette
P_L = pressure applied to the lower burette (20 psi)
P_u = pressure applied to the upper burette (5 psi)
γ_w = specific weight of water

The calculated permeability is then corrected for the temperature at the time of reading. This correction is made from tables of viscosity and the following equation:

$$K_{20} + K_T \frac{\eta_{test}}{\eta_{20}}$$

Where, K_{20} = permeability at 20°C
K_T = permeability calculated at the temperature of the room at the time of testing
η_{test} = viscosity of water at the testing temperature
η_{20} = viscosity of water at 20°C

Flexible wall permeabilities were determined based on the ASTM Draft Procedure "Test Method for Measurement of Hydraulic Conductivity of Saturated Fine-Grained Materials Using a Flexible Wall Permeameter." Permeability measurements were conducted utilizing two (2) Soiltest Model 455 Flexible-Wall Permeameters. A 0.01 normal calcium sulfate solution was used as the permeant. All permeability values presented have been corrected to 20°C to account for slight temperature fluctuations.

*NOTE: Sample ST-1 from MW-2 at 8.0 to 10.0 ft. had too much sand and gravel to be tested by this method.

CONESTOGA-ROVERS & ASSOCIATES, INC.
GOLD SHIELD SOLVENTS
GRAND RAPIDS, MI

JOB NO. 89300

FLEXIBLE WALL PERMEABILITIES

PERMEABILITY = K = alpha * 1/(t1-t2) *ln(Head @ t1 - Head @ t2)
t

Head = (S0 - V /a) - (S0 - V /a) -(P -P /0.0142)
low low up up low up

alpha = 0.5(a +a)/(1 + a /a) * (L/A)
up low up low

SAMPLE	ST-4			TECHNICIAN	RJT
DESCRIPTION	LT. BROWN SILT WITH SOME SAND AND CLAY				
LENGTH(cm)	9.50				
DIAMETER(cm)	7.20	DEPTH	18.0 TO 20.0 FT.		
WEIGHT(ml)	834.3			PERMEANT	0.01N CALCIUM SULFATE
% MOISTURE	13.6	A(upper)	1.976	PSI(upper)	5.0
DENSITY(gm/cc)	2.16	A(lower)	1.976	PSI(lower)	20.0
DATE	6/5/89 - 6/8/89	A(sample)	40.72	PSI(chamber)	30.0
PERMEAMETER #	5	alpha	0.231	GRADIENT	111.1

elapsed time (min)	V (ml) up	V (ml) low	Head	dt(min)	dt(sec)	ln(Ht /Ht) 1 2	K t	Temp. (celsius)		K 20
0.00	47.2	5.2	1077.6	0.0	0	-	-			-
125.00	45.0	5.7	1076.2	125.0	7500	1.3E-03	3.90E-08	23.0		3.61E-08
240.00	44.0	6.1	1075.5	115.0	6900	6.6E-04	2.20E-08	24.0	*	1.98E-08
355.00	43.2	6.7	1074.8	115.0	6900	6.6E-04	2.20E-08	25.0		1.93E-08
1265.00	37.1	12.2	1068.9	910.0	54600	5.5E-03	2.31E-08	24.0		2.09E-08
1355.00	36.6	12.8	1068.4	90.0	5400	5.2E-04	2.22E-08	23.5		2.03E-08
1415.00	36.2	13.1	1068.0	60.0	3600	3.3E-04	2.12E-08	23.5		1.94E-08
1500.00	35.8	13.6	1067.6	85.0	5100	4.3E-04	1.93E-08	24.0		1.74E-08
1575.00	35.3	14.0	1067.1	75.0	4500	4.3E-04	2.19E-08	24.0		1.97E-08
1655.00	34.7	14.5	1066.6	80.0	4800	5.2E-04	2.51E-08	25.0		2.20E-08
1735.00	34.2	15.0	1066.1	80.0	4800	4.7E-04	2.28E-08	25.0	-	2.00E-08

* WHERE PERMEABILITY STABILIZED AND AVERAGING BEGAN
- WHERE AVERAGING ENDED.

AVERAGE STABILIZED PERMEABILITY = 1.99E-08 cm/sec

CONESTOGA-ROVERS & ASSOCIATES, INC.
GOLD SHIELD SOLVENTS
GRAND RAPIDS, MI

JOB NO. 89300

FLEXIBLE WALL PERMEABILITIES

PERMEABILITY = K = alpha * 1/(t1-t2) *ln(Head @ t1 - Head @ t2)
t

Head = (50 - V /a) - (50 - V /a) -(P -P /0.0142)
low low up up low up

alpha = 0.5(a +a)/(1 + a /a) * (L/A)
up low up low

SAMPLE	ST-8			TECHNICIAN	RJT
DESCRIPTION	GRAY LEAN CLAY				
LENGTH(cm)	8.70				
DIAMETER(cm)	7.20	DEPTH	26.0 TO 28.0 FT.		
WEIGHT(ml)	855.0			PERMEANT	0.01N CALCIUM SULFATE
% MOISTURE	20.7	A(upper)	2.075	PSI(upper)	5.0
DENSITY(gm/cc)	2.41	A(lower)	2.083	PSI(lower)	20.0
DATE	6/5/89 - 6/8/89	A(sample)	40.72	PSI(chamber)	30.0
PERMEAMETER #	6	alpha	0.223	GRADIENT	121.3

elapsed time (min)	V (ml) up	V (ml) low	Head	dt(min)	dt(sec)	ln(Ht /Ht) 1 2	K t	Temp. (celsius)		K 20
0.00	47.6	5.4	1076.6	0.0	0	-	-			-
125.00	46.8	5.7	1076.1	125.0	7500	4.9E-04	1.46E-08	23.0		1.35E-08
240.00	46.4	5.9	1075.8	115.0	6900	2.7E-04	8.66E-09	24.0	*	7.81E-09
355.00	46.0	6.0	1075.5	115.0	6900	2.2E-04	7.22E-09	25.0		6.34E-09
1265.00	43.7	8.2	1073.4	910.0	54600	2.0E-03	8.21E-09	24.0		7.41E-09
1355.00	43.6	8.4	1073.2	90.0	5400	1.3E-04	5.54E-09	23.5		5.06E-09
1415.00	43.4	8.5	1073.1	60.0	3600	1.3E-04	8.32E-09	23.5		7.60E-09
1500.00	43.3	8.6	1073.0	85.0	5100	9.0E-05	3.91E-09	24.0		3.53E-09
1575.00	43.2	8.7	1072.9	75.0	4500	9.0E-05	4.43E-09	24.0		4.00E-09
1655.00	43.0	8.9	1072.7	80.0	4800	1.6E-04	7.28E-09	25.0		6.39E-09
1685.00	42.9	8.9	1072.6	30.0	1800	6.7E-05	8.32E-09	25.0	-	7.30E-09

* WHERE PERMEABILITY STABILIZED AND AVERAGING BEGAN
- WHERE AVERAGING ENDED.

AVERAGE STABILIZED PERMEABILITY = 6.16E-09 cm/sec

DELL ENGINEERING, INC.
245 EAST LAKEWOOD BLVD.
HOLLAND, MI 49424-2066
PHONE 616-396-1296
FAX 616-396-7924

TRANSMITTAL

TO: Conestoga-Rovers & Associates, Inc.
382 West County Road D
St. Paul, Minnesota 55112

DATE: May 25, 1989

PROJECT: D.E.#89300

MAY 25 89

ATTN: Jon Michels

WE ARE TRANSMITTING ____ HEREWITH ____ UNDER SEPARATE COVER

QUANTITY	DESCRIPTION
One (1) copy	Sieve analysis test results

ISSUED FOR ____ REVIEW & COMMENT ____ APPROVAL ____ INFORMATION
____ CONSTRUCTION ✓ YOUR FILE ____ AS REQUESTED

REMARKS

DISTRIBUTION

file

DELL ENGINEERING, INC.

BY: R. Joseph Trojan

R. Joseph Trojan
Geologist

SIEVE ANALYSIS

JOB NUMBER: 89300 DATE: 5/23/89

SAMPLE NUMBER: MW-1 SS-1 DEPTH: 0.5 TO 2.0 FT.

SOIL SOURCE: GOLD SHIELD SOLVENTS - GRAND RAPIDS, MI

DESCRIPTION: BROWN FINE GRAINED POORLY GRADED SAND WITH CLAY

CLASSIFICATION: SP-SC

TECHNICIAN: RJT

LOSS BY WASHING

Pan Weight (gm).....	7.0	Weight of Soil Before Washing (gm)..	95.90
Pan and Dry Soil Weight (gm).....	102.9	Weight of Soil After Washing (gm)...	85.60
Drying Container (gm).....	120.1	Difference (gm).....	10.30
Drying Container and Dry Soil After Washing (gm).....	205.7	Percent Lost by Washing.....	10.74

SIEVE ANALYSIS

Sieve size	Sieve Weight	Sieve and Soil Weight	Weight Retained	% Retained	% Retained Cumulative	% Passing
#4	532.5	543.1	10.6	11.05	11.05	88.95
#10	456.3	462.7	6.4	6.67	17.73	82.27
#40	398.8	412.9	14.1	14.70	32.43	67.57
#100	422.5	462.6	40.1	41.81	74.24	25.76
#200	294.2	308.2	14.0	14.60	88.84	11.16
PAN	377.0	378.4	0.4	11.16	100.00	0.00
TOTAL	2481.3	2567.9	85.6	100.0	-	-

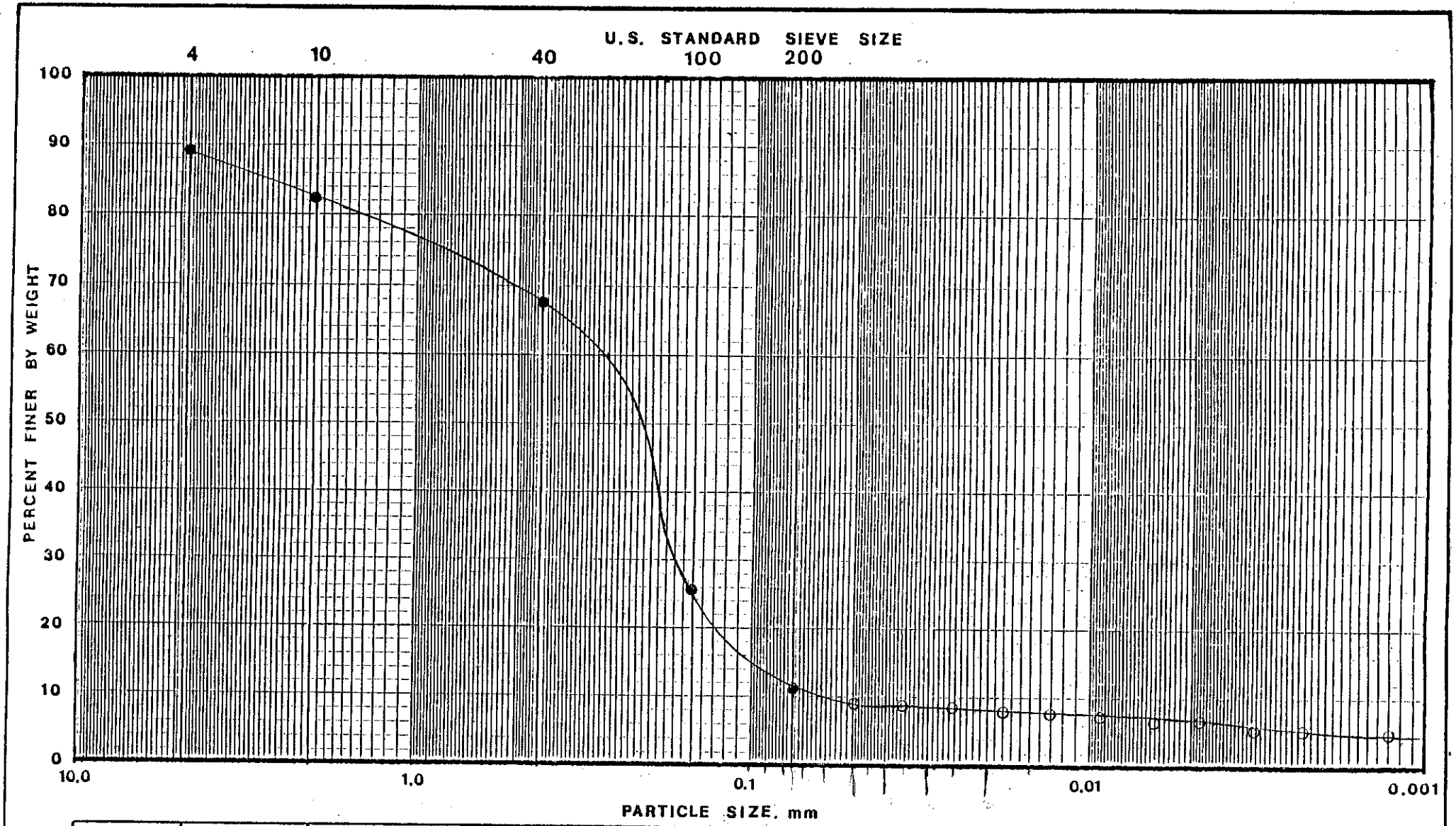
REMARKS: %GRAVEL = 11.05 %SAND = 77.79 %FINES = 11.16

GRAIN SIZE ANALYSIS - HYDROMETER METHOD

Project	CONESTOGA-ROVERS AND ASSOCIATES, INC.	Job Number	89300
Location of Project	GOLD SHIELD SOLVENTS - GRAND RAPIDS, MI	Sample Number	MW-1 SS1
Description of soil	BROWN FINE GRAINED POORLY GRADED SAND WITH CLAY AND SILT (SP-SC)	Depth of Sample	0.5 TO 2.0 FT.
Tested By	RJT	Date Tested	6/5/89 - 6/7/89

Specific Gravity	2.68
Specific Gravity Correction (a)	0.99
Zero Correction	4
Sample Weight (gm)	50

Date	Time	Elapsed Time(t)	T (C)	Actual Read(Ra)	Temp² Corr(Ct)	Corr Read(Rc)	% Finer	Meas. corr R	L²	L/t	K²	D(mm)
6/5/89	14:46	0	21.0	24.0	0.2	20.2	40.0	25.0	12.2	-	0.0131	
		0.25	21.0	16.0	0.2	12.2	24.2	17.0	13.5	54.05	0.0131	0.0963
		0.5	21.0	10.0	0.2	6.2	12.3	11.0	14.5	28.99	0.0131	0.0705
	14:47	1	21.0	8.5	0.2	4.7	9.3	9.5	14.7	14.74	0.0131	0.0503
	14:48	2	21.0	8.2	0.2	4.4	8.7	9.2	14.8	7.40	0.0131	0.0356
	14:50	4	21.0	8.0	0.2	4.2	8.3	9.0	14.8	3.71	0.0131	0.0252
	14:54	8	21.0	7.8	0.2	4.0	7.9	8.8	14.9	1.86	0.0131	0.0179
	15:01	15	21.0	7.7	0.2	3.9	7.7	8.7	14.9	0.99	0.0131	0.0130
	15:16	30	21.0	7.3	0.2	3.5	6.9	8.3	14.9	0.50	0.0131	0.0092
	15:46	60	21.0	7.0	0.2	3.2	6.3	8.0	15.0	0.25	0.0131	0.0065
	16:46	120	22.0	6.8	0.4	3.2	6.3	7.8	15.0	0.13	0.0130	0.0046
	18:46	240	22.0	6.1	0.4	2.5	4.9	7.1	15.1	0.06	0.0130	0.0033
	22:46	480	23.0	6.0	0.7	2.7	5.3	7.0	15.2	0.03	0.0128	0.0023
6/6/89	14:46	1440	23.0	5.8	0.7	2.5	5.0	6.8	15.2	0.01	0.0128	0.0013
6/7/89	14:46	2880	23.0	5.7	0.7	2.4	4.8	6.7	15.2	0.01	0.0128	0.0009



GRAVEL 0.17%	COARSE SAND 0.9%	MEDIUM SAND 3.0%	FINE SAND 36.0%	SILT OR CLAY 60.0%
BORING NO. MW-1 SS-3	DEPTH 4.0 to 6.0 ft.	CLASSIFICATION CL	REMARKS Sieve and Hydrometer Analysis	

PARTICLE SIZE DISTRIBUTION	DELL ENGINEERING Environmental Consultants HOLLAND, MICHIGAN 49423	Conestoga-Rovers & Associates, Inc. Gold Shield Solvents Grand Rapids, MI	JOB NO. 89300 DATE 6/8/89

SIEVE ANALYSIS

JOB NUMBER: 89300 DATE: 5/23/89

SAMPLE NUMBER: MW-1 SS-3 DEPTH: 4.0 TO 6.0 FT.

SOIL SOURCE: GOLD SHIELD SOLVENTS - GRAND RAPIDS, MI

DESCRIPTION: REDDISH BROWN SANDY LEAN CLAY

CLASSIFICATION: CL

TECHNICIAN: RJT

LOSS BY WASHING

Pan Weight (gm).....	6.8	Weight of Soil Before Washing (gm)..	86.50
Pan and Dry Soil Weight (gm).....	93.3	Weight of Soil After Washing (gm)...	34.90
Drying Container (gm).....	120.1	Difference (gm).....	51.60
Drying Container and Dry Soil After Washing (gm).....	155.0	Percent Lost by Washing.....	59.65

SIEVE ANALYSIS

Sieve size	Sieve Weight	Sieve and Soil Weight	Weight Retained	% Retained	% Retained Cumulative	% Passing
#4	532.5	532.6	0.1	0.12	0.12	99.88
#10	456.3	457.1	0.9	0.92	1.04	98.96
#40	398.8	401.4	2.6	3.01	4.05	95.95
#100	422.5	442.0	19.5	22.54	26.59	73.41
#200	294.2	305.8	11.6	13.41	40.00	60.00
PAN	377.0	378.4	0.3	60.00	100.00	0.00
TOTAL	2481.3	2517.3	34.9	100.0	-	-

REMARKS: %GRAVEL = 0.12 %SAND = 39.88 %FINES = 60.00

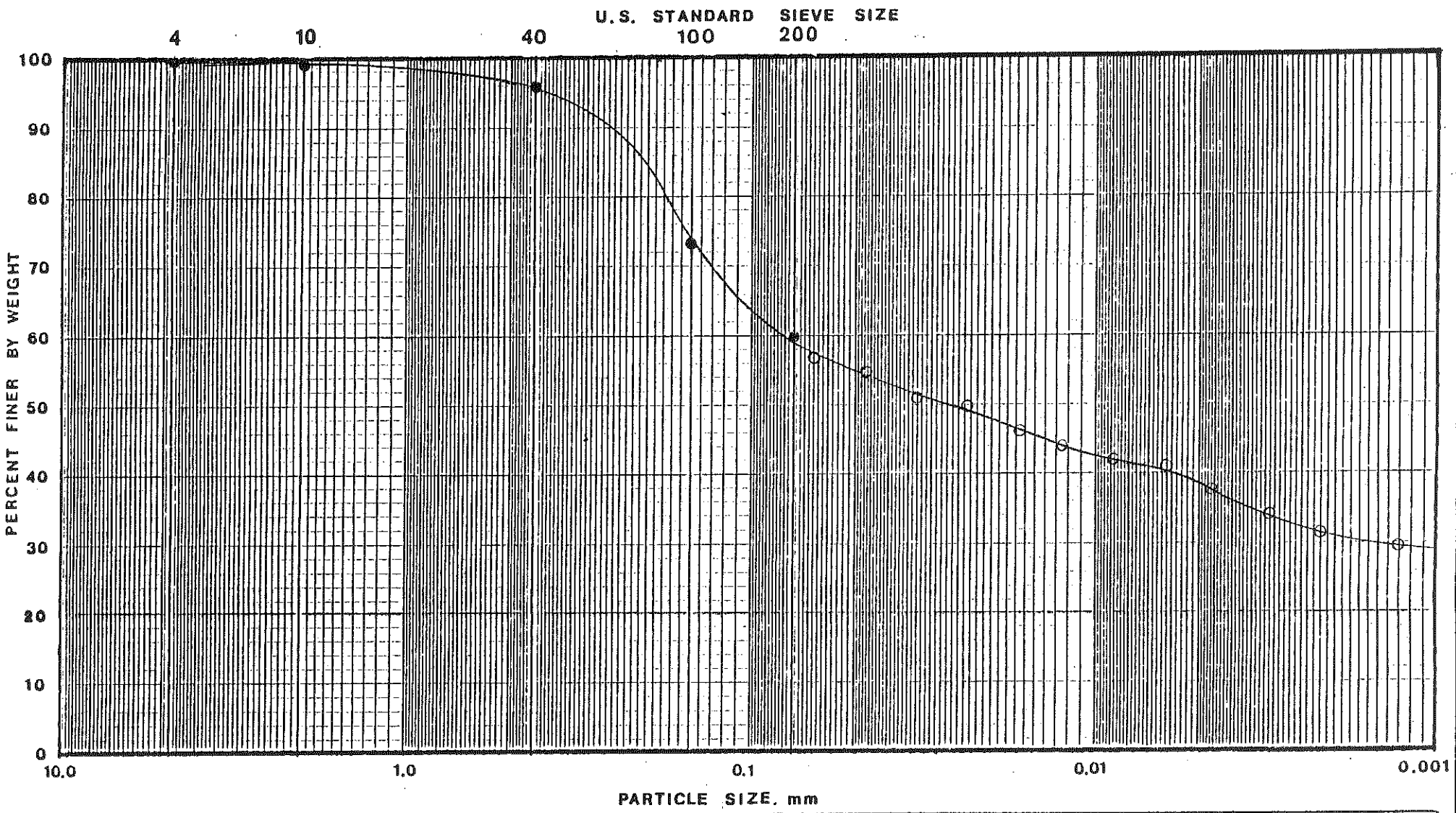
DELL ENGINEERING, INC.

GRAIN SIZE ANALYSIS - HYDROMETER METHOD

Project	CONESTOGA-ROVERS AND ASSOCIATES, INC.	Job Number	89300
Location of Project	GOLD SHIELD SOLVENTS - GRAND RAPIDS, MI	Sample Number	MW-1 SS-3
Description of soil	REDDISH BROWN SANDY LEAN CLAY (CL)	Depth of Sample	4.0 TO 6.0 FT.
Tested By	RJT	Date Tested	6/2/89 - 6/5/89

Specific Gravity	2.72
Specific Gravity Correction (a)	0.99
Zero Correction	0
Sample Weight (gm)	50

Date	Time	Elapsed Time(t)	T (C)	Actual Read(Ra)	Temp* Corr(Ct)	Corr Read(Rc)	% Finer	Men. corr R	L*	L/t	K*	D(mm)
6/2/89	9:50	0	19.0	35.0	-0.3	34.7	68.7	36.0	10.4	-	0.0136	
		0.25	19.0	30.0	-0.3	29.7	58.8	31.0	11.2	44.86	0.0136	0.0911
		0.5	19.0	28.7	-0.3	28.4	56.2	29.7	11.4	22.86	0.0136	0.0650
	9:51	1	19.0	27.8	-0.3	27.5	54.5	28.8	11.6	11.58	0.0136	0.0463
	9:52	2	19.0	26.0	-0.3	25.7	50.9	27.0	11.9	5.94	0.0136	0.0331
	9:54	4	19.0	25.3	-0.3	25.0	49.5	26.3	12.0	3.00	0.0136	0.0235
	9:58	8	19.0	23.6	-0.3	23.3	46.1	24.6	12.3	1.53	0.0136	0.0168
	10:05	15	19.0	22.5	-0.3	22.2	44.0	23.5	12.4	0.83	0.0136	0.0124
	10:20	30	19.0	21.5	-0.3	21.2	42.0	22.5	12.6	0.42	0.0136	0.0088
	10:50	60	20.0	20.8	0.0	20.8	41.2	21.8	12.7	0.21	0.0134	0.0062
	11:40	110	20.0	18.9	0.0	18.9	37.4	19.9	13.0	0.12	0.0134	0.0046
	13:50	240	21.0	17.0	0.2	17.2	34.1	18.0	13.3	0.06	0.0133	0.0031
	17:50	480	22.0	15.6	0.4	16.0	31.7	16.6	13.5	0.03	0.0131	0.0022
6/3/89	10:15	1465	21.0	14.8	0.2	15.0	29.7	15.8	13.7	0.01	0.0133	0.0013
6/5/89	8:00	4210	20.0	14.0	0.0	14.0	27.7	15.0	13.8	0.00	0.0134	0.0008



11.0% GRAVEL	COARSE SAND 6.7%	MEDIUM SAND 14.7%	FINE SAND 56.4%	SILT OR CLAY 11.2%
BORING NO. MW-1 SS-1	DEPTH 0.5 to 2.0 ft.	CLASSIFICATION SP-SC	REMARKS Sieve and Hydrometer Analysis	

PARTICLE SIZE DISTRIBUTION	DELL ENGINEERING Environmental Consultants HOLLAND, MICHIGAN 49423	Conestoga-Rovers & Associates, Inc. Cold Shield Solvents Grand Rapids, MI	JOB NO. 89300 DATE. 6/8/89

SIEVE ANALYSIS

JOB NUMBER: 89300 DATE: 5/23/89

SAMPLE NUMBER: MW-1 SS-5 DEPTH: 8.0 TO 10.0 FT.

SOIL SOURCE: GOLD SHIELD SOLVENTS - GRAND RAPIDS, MI

DESCRIPTION: BROWN FINE TO MEDIUM GRAINED POORLY GRADED SAND WITH GRAVEL

CLASSIFICATION: SP

TECHNICIAN: RJT

LOSS BY WASHING

Pan Weight (gm).....	6.8	Weight of Soil Before Washing (gm)..	189.10
Pan and Dry Soil Weight (gm).....	195.9	Weight of Soil After Washing (gm)...	183.60
Drying Container (gm).....	120.1	Difference (gm).....	5.50
Drying Container and Dry Soil After Washing (gm).....	303.7	Percent Lost by Washing.....	2.91

SIEVE ANALYSIS

Sieve size	Sieve Weight	Sieve and Soil Weight	Weight Retained	% Retained	% Retained Cumulative	% Passing
#4	532.5	583.4	50.9	26.92	26.92	73.08
#10	456.3	469.3	13.0	6.87	33.79	66.21
#40	398.8	413.6	14.8	7.83	41.62	58.38
#100	422.5	522.2	99.7	52.72	94.34	5.66
#200	294.2	299.3	5.1	2.70	97.04	2.96
PAN	377.0	378.4	0.1	2.96	100.00	0.00
TOTAL	2481.3	2666.2	183.6	100.0	-	-

REMARKS: %GRAVEL = 26.92 %SAND = 70.12 %FINES = 2.96

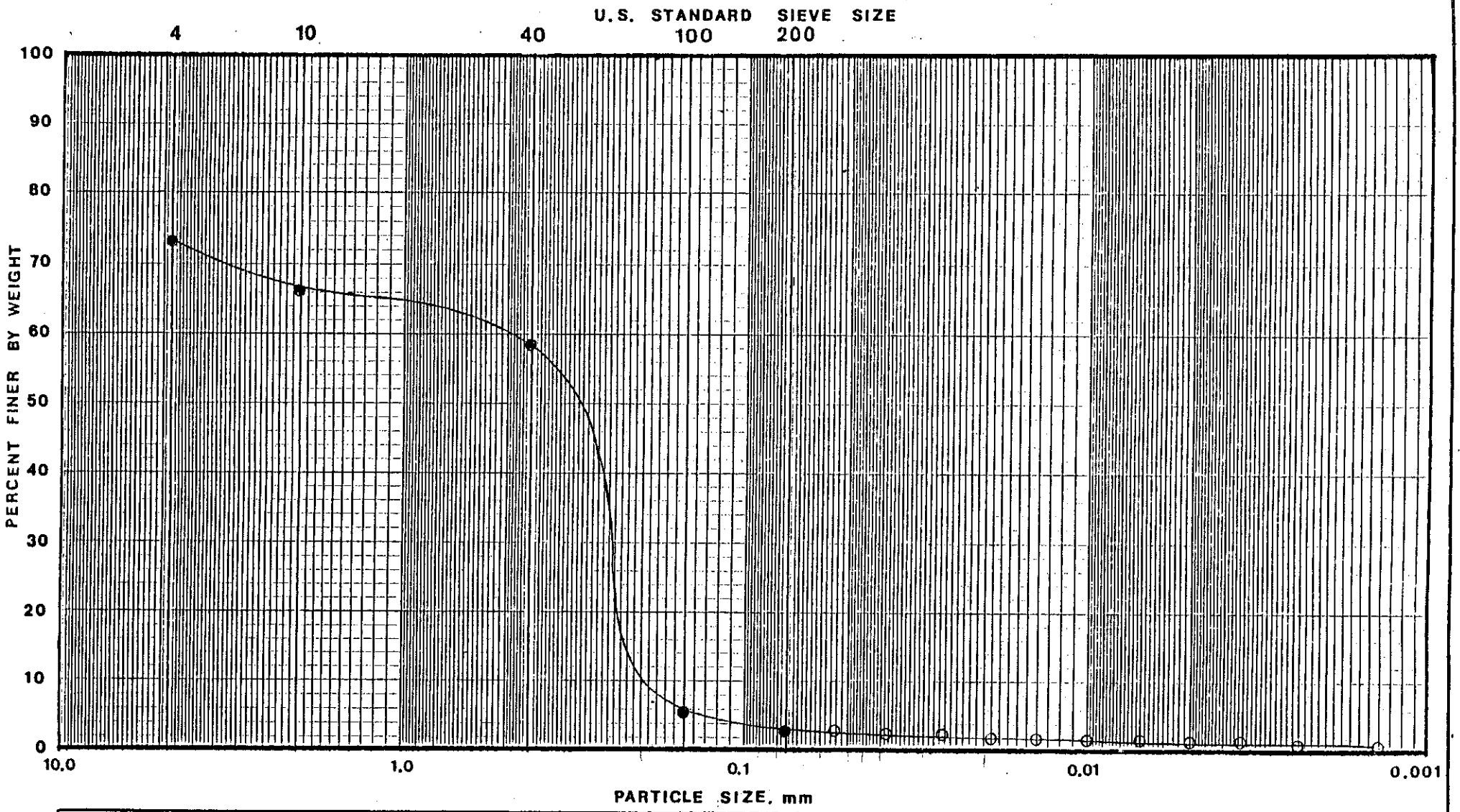
DELL ENGINEERING, INC.

GRAIN SIZE ANALYSIS - HYDROMETER METHOD

Project	CONESTOGA-ROVERS AND ASSOCIATES, INC.	Job Number	89300
Location of Project	GOLD SHIELD SOLVENTS - GRAND RAPIDS, MI	Sample Number	MW-1 SS-5
Description of soil	FINE TO MED. GRAINED POORLY GRADED SAND WITH GRAVEL (SP)	Depth of Sample	8.0 TO 10.0 FT.
Tested By	RJT	Date Tested	6/2/89 - 6/5/89

Specific Gravity	2.64
Specific Gravity Correction (a)	1.00
Zero Correction	2
Sample Weight (gm)	50

Date	Time	Elapsed Time(t)	T (C)	Actual Read(Ra)	Temp± Corr(Ct)	Corr Read(Rc)	% Finer	Men. corr R	Ls	L/t	Ks	D(mm)
6/2/89	9:00	0	19.0	9.0	-0.3	6.7	13.4	10.0	14.7	-	0.0138	
		0.25	19.0	4.2	-0.3	1.9	3.8	5.2	15.4	61.79	0.0138	0.1085
		0.5	19.0	3.9	-0.3	1.6	3.2	4.9	15.5	30.99	0.0138	0.0768
	9:01	1	19.0	3.8	-0.3	1.5	3.0	4.8	15.5	15.51	0.0138	0.0544
	9:02	2	19.0	3.6	-0.3	1.3	2.6	4.6	15.5	7.77	0.0138	0.0385
	9:04	4	19.0	3.5	-0.3	1.2	2.4	4.5	15.6	3.89	0.0138	0.0272
	9:08	8	19.0	3.4	-0.3	1.1	2.2	4.4	15.6	1.95	0.0138	0.0193
	9:15	15	19.0	3.3	-0.3	1.0	2.0	4.3	15.6	1.04	0.0138	0.0141
	9:30	30	19.0	3.2	-0.3	0.9	1.8	4.2	15.6	0.52	0.0138	0.0100
	10:00	60	20.0	2.9	0.0	0.9	1.8	3.9	15.7	0.26	0.0137	0.0070
	11:00	120	20.0	2.8	0.0	0.8	1.6	3.8	15.7	0.13	0.0137	0.0050
	13:00	240	21.0	2.4	0.2	0.6	1.2	3.4	15.7	0.07	0.0135	0.0035
	17:00	480	22.0	1.9	0.4	0.3	0.6	2.9	15.8	0.03	0.0133	0.0024
6/3/89	10:15	1515	21.0	1.5	0.2	-0.3	-0.6	2.5	15.9	0.01	0.0135	0.0014
6/5/89	8:00	4260	20.0	1.1	0.0	-0.9	-1.8	2.1	16.0	0.00	0.0137	0.0008



26.9% GRAVEL	COARSE SAND 6.9%	MEDIUM SAND 7.8%	FINE SAND 55.4%	SILT OR CLAY 3.0%
BORING NO. MW-1 SS-5	DEPTH 8.0 to 10.0 ft.	CLASSIFICATION SP	REMARKS Sieve and Hydrometer Analysis	

PARTICLE SIZE DISTRIBUTION

DELL ENGINEERING
Environmental Consultants
HOLLAND, MICHIGAN 49423

Conestoga-Rovers & Associates, Inc.
Gold Shield Solvents
Grand Rapids, MI

JOB NO. 89300

DATE 6/8/89

SIEVE ANALYSIS

JOB NUMBER: 89300 DATE: 5/18/89

SAMPLE NUMBER: MW-1 SS-6 DEPTH: 10.0 TO 12.0 FT.

SOIL SOURCE: GOLD SHIELD SOLVENTS - GRAND RAPIDS, MI

DESCRIPTION: BROWN CLAYEY SAND WITH GRAVEL

CLASSIFICATION: SC

TECHNICIAN: RJT

LOSS BY WASHING

Pan Weight (gm).....	7.1	Weight of Soil Before Washing (gm)..	133.60
Pan and Dry Soil Weight (gm).....	140.7	Weight of Soil After Washing (gm)...	114.00
Drying Container (gm).....	120.2	Difference (gm).....	19.60
Drying Container and Dry Soil After Washing (gm).....	234.2	Percent Lost by Washing.....	14.67

SIEVE ANALYSIS

Sieve size	Sieve Weight	Sieve and Soil Weight	Weight Retained	% Retained	% Retained Cumulative	% Passing
#4	532.5	589.0	56.5	42.29	42.29	57.71
#10	456.3	472.9	16.6	12.43	54.72	45.28
#40	398.8	412.5	13.7	10.25	64.97	35.03
#100	422.5	444.0	21.5	16.09	81.06	18.94
#200	294.2	299.3	5.1	3.82	84.88	15.12
PAN	377.9	378.4	0.6	15.12	100.00	0.00
TOTAL	2481.3	2596.1	114.0	100.0	-	-

REMARKS: %GRAVEL = 42.29 %SAND = 42.59 %FINES = 15.12

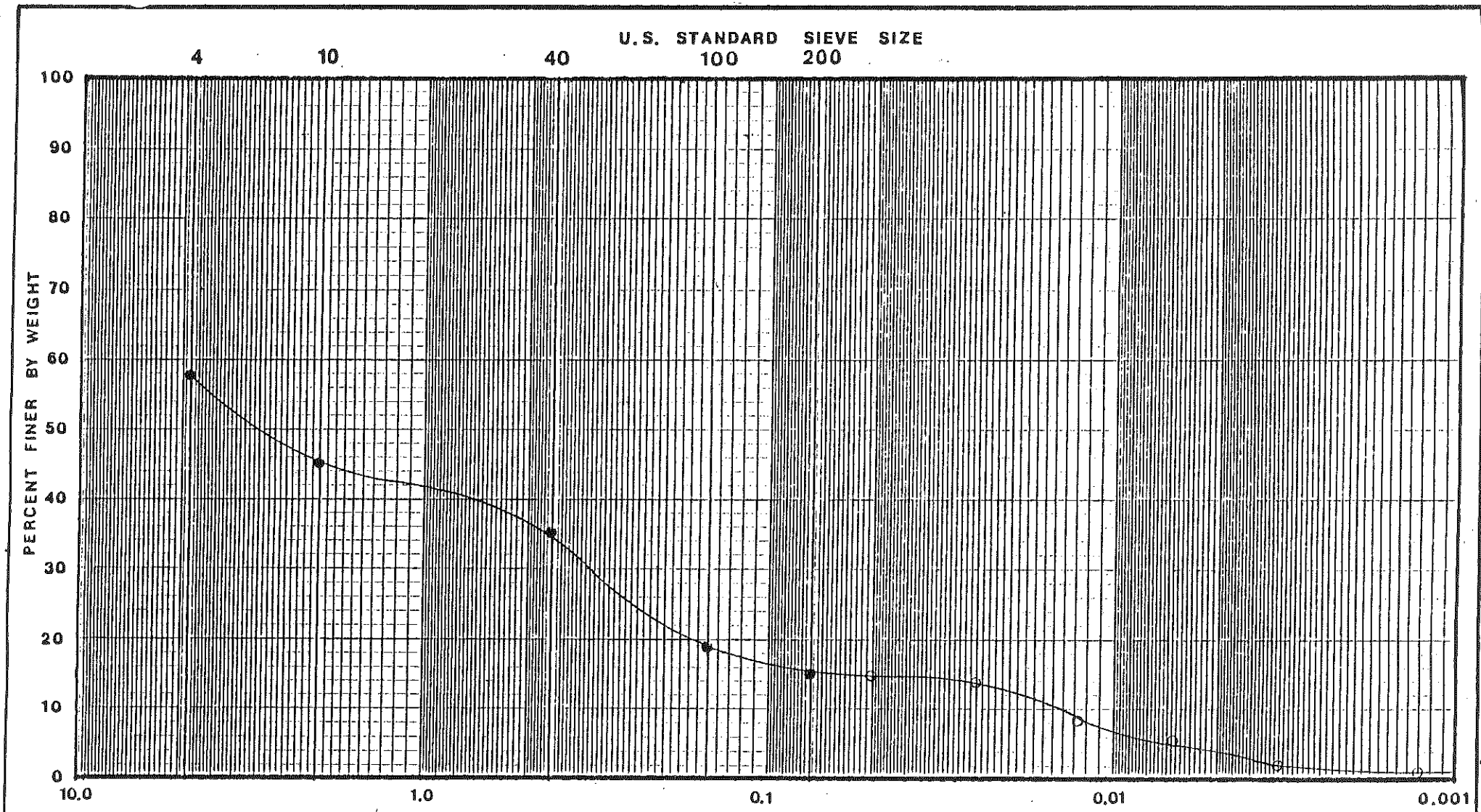
DELL ENGINEERING, INC.

GRAIN SIZE ANALYSIS - HYDROMETER METHOD

Project	CONESTOGA-ROVERS AND ASSOCIATES, INC.	Job Number	89300
Location of Project	GOLD SHIELD SOLVENTS - GRAND RAPIDS, MI	Sample Number	MW-1 SS-6
Description of soil	BROWN CLAYEY SAND WITH GRAVEL (SC)	Depth of Sample	10.0 TO 12.0 FT.
Tested By	RJT	Date Tested	5/24/89 - 5/26/89

Specific Gravity	2.69
Specific Gravity Correction (a)	0.99
Zero Correction	4
Sample Weight (gm)	50

Date	Time	Elapsed Time(t)	T (C)	Actual Read(Ra)	Temp# Corr(Ct)	Corr Read(Rc)	% Finer	Men. corr R	Lx	L/t	Kx	D(mm)
5/24/89	9:45	0	21.0	21.0	0.2	17.2	34.1	22.0	12.7	-	0.0133	
		0.25	21.0	14.5	0.2	10.7	21.2	15.5	13.8	55.03	0.0133	0.0987
		0.5	21.0	12.0	0.2	8.2	16.2	13.0	14.2	28.34	0.0133	0.0708
	9:46	1	21.0	11.3	0.2	7.5	14.9	12.3	14.3	14.28	0.0133	0.0503
	9:47	2	21.0	11.0	0.2	7.2	14.3	12.0	14.3	7.17	0.0133	0.0356
	9:49	4	21.0	10.9	0.2	7.1	14.1	11.9	14.3	3.59	0.0133	0.0252
	9:53	8	21.0	10.2	0.2	6.4	12.7	11.2	14.5	1.81	0.0133	0.0179
	10:00	16	21.0	7.9	0.2	4.1	8.1	8.9	14.8	0.93	0.0133	0.0128
	10:15	30	21.0	7.7	0.2	3.9	7.7	8.7	14.9	0.50	0.0133	0.0094
	10:45	60	21.0	6.6	0.2	2.8	5.5	7.6	15.1	0.25	0.0133	0.0067
	11:45	120	21.0	5.7	0.2	1.9	3.8	6.7	15.2	0.13	0.0133	0.0047
	13:45	240	22.0	4.6	0.4	1.0	2.0	5.6	15.4	0.06	0.0131	0.0033
	17:45	480	24.0	3.9	1.0	0.9	1.8	4.9	15.5	0.03	0.0128	0.0023
5/25/89	9:45	1440	23.0	3.8	0.7	0.5	1.0	4.8	15.5	0.01	0.0130	0.0013
5/26/89	14:25	3165	22.0	3.6	0.4	0.0	0.0	4.6	15.5	0.00	0.0131	0.0009



GRAVEL 42.3%	COARSE SAND 12.4%	MEDIUM SAND 10.3%	FINE SAND 19.9%	SILT OR CLAY 15.1%
BORING NO. MW-1 SS-6	DEPTH 10.0 to 12.0 ft.	CLASSIFICATION SC	REMARKS Sieve and Hydrometer Analysis	

PARTICLE SIZE DISTRIBUTION	DELL ENGINEERING Environmental Consultants HOLLAND, MICHIGAN 49423	Conestoga-Rovers & Associates, Inc. Gold Shield Solvents Grand Rapids, MI	JOB NO. 89300 DATE 6/8/89

SIEVE ANALYSIS

JOB NUMBER: 89300 DATE: 5/23/89

SAMPLE NUMBER: MW-1 SS-12,13 (composite) DEPTH: 24.0 to 28.0 FT.

SOIL SOURCE: GOLD SHIELD SOLVENTS - GRAND RAPIDS, MI

DESCRIPTION: DARK GRAY LEAN CLAY

CLASSIFICATION: CL

TECHNICIAN: RJT

LOSS BY WASHING

Pan Weight (gm).....	7.1	Weight of Soil Before Washing (gm)..	236.20
Pan and Dry Soil Weight (gm).....	243.3	Weight of Soil After Washing (gm)...	36.40
Drying Container (gm).....	120.3	Difference (gm).....	199.80
Drying Container and Dry Soil After Washing (gm).....	156.7	Percent Lost by Washing.....	84.59

SIEVE ANALYSIS

Sieve size	Sieve Weight	Sieve and Soil Weight	Weight Retained	% Retained	% Retained Cumulative	% Passing
#4	532.5	534.3	1.8	0.76	0.76	99.24
#10	456.3	458.1	1.8	0.76	1.52	98.48
#40	398.8	404.7	5.9	2.50	4.02	95.98
#100	422.5	437.5	15.0	6.35	10.37	89.63
#200	294.2	305.5	11.3	4.78	15.16	84.84
PAN	377.0	378.4	0.6	84.84	100.00	0.00
TOTAL	2481.3	2518.5	36.4	100.0	-	-

REMARKS: %GRAVEL = 0.76 %SAND = 14.39 %FINES = 84.84

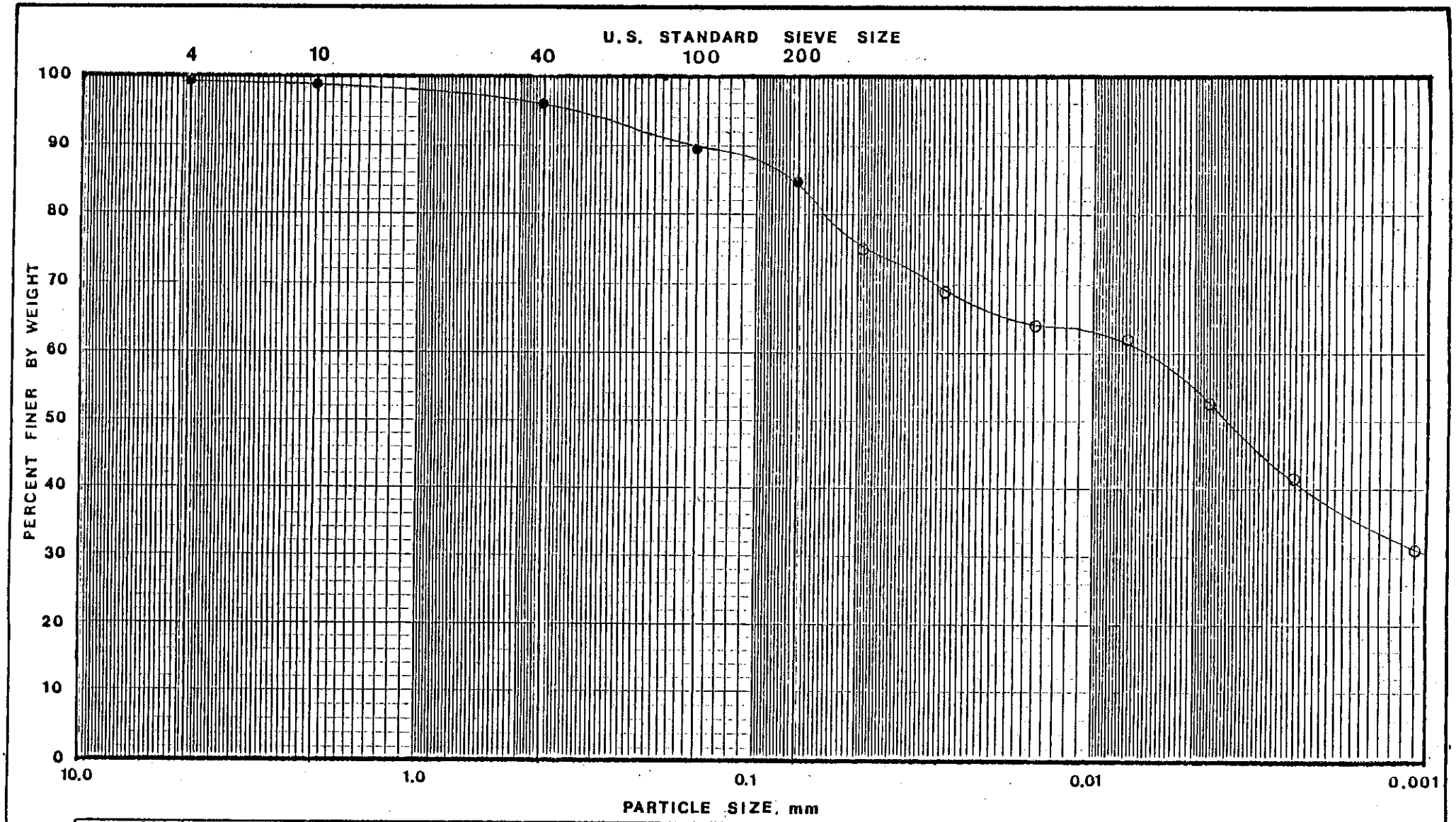
DELL ENGINEERING, INC.

GRAIN SIZE ANALYSIS - HYDROMETER METHOD

Project	CONESTOGA-ROVERS AND ASSOCIATES, INC.	Job Number	89300
Location of Project	GOLD SHIELD SOLVENTS - GRAND RAPIDS, MI	Sample Number	MW-1 SS-12,13 (composite)
Description of soil	DARK GRAY LEAN CLAY (CL)	Depth of Sample	24.0 TO 28.0 FT.
Tested By	RJT	Date Tested	6/2/89 - 6/5/89

Specific Gravity	2.86
Specific Gravity Correction (a)	0.96
Zero Correction	0
Sample Weight (gm)	100

Date	Time	Elapsed Time(t)	T (C)	Actual Read(Ra)	Temp± Corr(Ct)	Corr Read(Rc)	% Finer	Men. corr R	LR	L/t	Kx	D(mm)
6/2/89	9:05	0	19.0	84.0	-0.3	83.7	80.4	85.0	2.4	-	0.0131	
		0.25	19.0	78.0	-0.3	77.7	74.6	79.0	3.3	13.38	0.0131	0.0479
		0.5	19.0	75.0	-0.3	74.7	71.7	76.0	3.8	7.67	0.0131	0.0363
	9:06	1	19.0	72.0	-0.3	71.7	68.8	73.0	4.3	4.33	0.0131	0.0273
	9:07	2	19.0	69.0	-0.3	68.7	66.0	70.0	4.8	2.41	0.0131	0.0203
	9:09	4	19.0	67.0	-0.3	66.7	64.0	68.0	5.1	1.29	0.0131	0.0149
	9:13	8	19.0	66.0	-0.3	65.7	63.1	67.0	5.3	0.66	0.0131	0.0107
	9:20	15	19.0	64.8	-0.3	64.5	61.9	65.8	5.5	0.37	0.0131	0.0079
	9:35	30	19.0	59.0	-0.3	58.7	56.4	60.0	6.5	0.22	0.0131	0.0061
	10:05	60	20.0	54.7	0.0	54.7	52.5	55.7	7.2	0.12	0.0129	0.0045
	11:05	120	20.0	49.8	0.0	49.8	47.8	50.8	8.0	0.07	0.0129	0.0033
	13:05	240	21.0	43.0	0.2	43.2	41.5	44.0	9.1	0.04	0.0127	0.0025
	17:05	480	22.0	37.2	0.4	37.6	36.1	38.2	10.0	0.02	0.0126	0.0018
6/3/89	10:15	1510	21.0	32.0	0.2	32.2	30.9	33.0	10.9	0.01	0.0127	0.0011
6/5/89	8:00	4255	20.0	27.2	0.0	27.2	26.1	28.2	11.7	0.00	0.0129	0.0007



0.8% GRAVEL	COARSE SAND 0.8%	MEDIUM SAND 2.5%	FINE SAND 11.1%	SILT OR CLAY 84.8%
BORING NO. MW-1 SS-12,13	DEPTH 24.0 to 28.0 ft.	CLASSIFICATION CL	REMARKS Sieve and Hydrometer Analysis	

PARTICLE SIZE DISTRIBUTION	DELL ENGINEERING Environmental Consultants HOLLAND, MICHIGAN 49423	Conestoga-Rovers & Associates, Inc. Gold Shield Solvents Grand Rapids, MI	J NO. 89300 DATE 6/8/89

S I E V E A N A L Y S I S

JOB NUMBER: 89300 DATE: 5/19/89

SAMPLE NUMBER: MW-1 SS-16 DEPTH: 32.0 TO 34.0 FT.

SOIL SOURCE: GOLD SHIELD SOLVENTS - GRAND RAPIDS, MI

DESCRIPTION: GRAYISH BROWN CLAYEY SAND

CLASSIFICATION: SC

TECHNICIAN: RJT

LOSS BY WASHING

Pan Weight (gm).....	7.0	Weight of Soil Before Washing (gm)..	133.40
Pan and Dry Soil Weight (gm).....	140.4	Weight of Soil After Washing (gm)...	71.90
Drying Container (gm).....	120.1	Difference (gm).....	61.50
Drying Container and Dry Soil After Washing (gm).....	192.0	Percent Lost by Washing.....	46.10

SIEVE ANALYSIS

Sieve size	Sieve Weight	Sieve and Soil Weight	Weight Retained	% Retained	% Retained Cumulative	% Passing
#4	532.5	534.8	2.3	1.72	1.72	98.28
#10	456.3	461.5	5.2	3.90	5.62	94.38
#40	398.8	407.4	8.6	6.45	12.07	87.93
#100	422.5	456.8	34.3	25.71	37.78	62.22
#200	294.2	313.6	19.4	14.54	52.32	47.68
PAN	377.0	378.4	2.1	47.68	100.00	0.00
TOTAL	2481.3	2552.5	71.9	100.0	-	-

REMARKS: %GRAVEL = 1.72 %SAND = 50.60 %FINES = 47.68

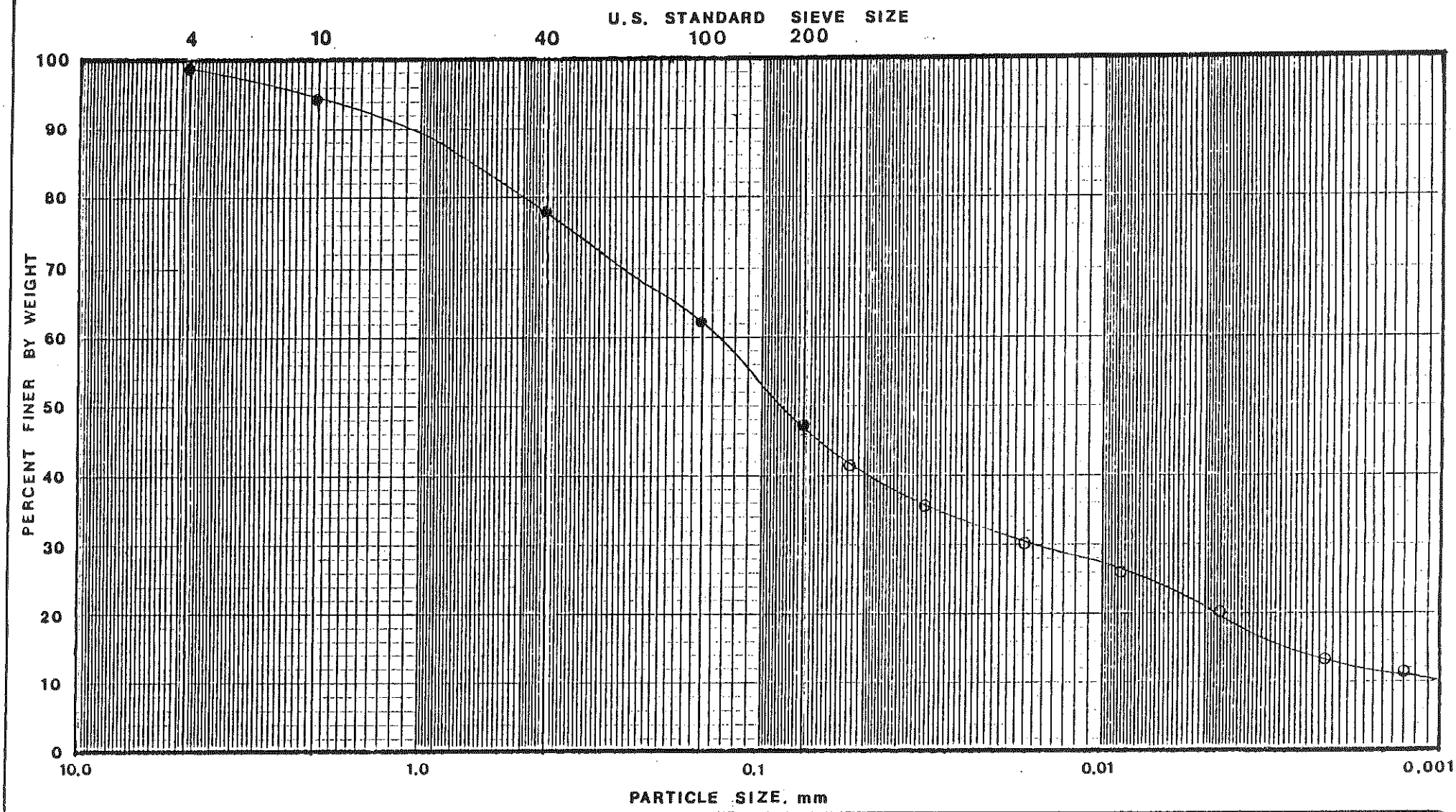
DELL ENGINEERING, INC.

GRAIN SIZE ANALYSIS - HYDROMETER METHOD

Project	CONESTOGA-ROVERS AND ASSOCIATES, INC.	Job Number	89300
Location of Project	GOLD SHIELD SOLVENTS - GRAND RAPIDS, MI	Sample Number	MW-1 SS-16
Description of soil	GRAYISH-BROWN CLAYEY SAND (SC)	Depth of Sample	32.0 TO 34.0 FT.
Tested By	RJT	Date Tested	6/5/89 - 6/7/89

Specific Gravity	2.73
Specific Gravity Correction (a)	0.98
Zero Correction	2
Sample Weight (gm)	50

Date	Time	Elapsed Time(t)	T (C)	Actual Read(Ra)	Tempt Corr(Ct)	Corr Read(Rc)	% Finer	Men. corr R	Lx	L/t	Kx	D(mm)
6/5/89	14:00	0	21.0	34.0	0.2	32.2	63.1	35.0	10.6	-	0.0131	
		0.25	21.0	25.0	0.2	23.2	45.5	26.0	12.0	48.14	0.0131	0.0909
		0.5	21.0	23.0	0.2	21.2	41.6	24.0	12.4	24.73	0.0131	0.0651
	14:01	1	21.0	21.9	0.2	20.1	39.4	22.9	12.5	12.54	0.0131	0.0464
	14:02	2	21.0	20.0	0.2	18.2	35.7	21.0	12.9	6.43	0.0131	0.0332
	14:04	4	21.0	18.5	0.2	16.7	32.7	19.5	13.1	3.28	0.0131	0.0237
	14:08	8	21.0	17.2	0.2	15.4	30.2	18.2	13.3	1.66	0.0131	0.0169
	14:15	15	21.0	16.1	0.2	14.3	28.0	17.1	13.5	0.90	0.0131	0.0124
	14:30	30	21.0	15.0	0.2	13.2	25.9	16.0	13.7	0.46	0.0131	0.0088
	15:00	60	21.0	13.9	0.2	12.1	23.7	14.9	13.9	0.23	0.0131	0.0063
	16:00	120	22.0	11.9	0.4	10.3	20.2	12.9	14.2	0.12	0.0130	0.0045
	18:00	240	22.0	9.6	0.4	8.0	15.7	10.6	14.6	0.06	0.0130	0.0032
	22:00	480	23.0	8.1	0.7	6.8	13.3	9.1	14.8	0.03	0.0128	0.0022
6/6/89	14:00	1440	23.0	7.2	0.7	5.9	11.6	8.2	15.0	0.01	0.0128	0.0013
6/7/89	14:00	2880	23.0	6.0	0.7	4.7	9.2	7.0	15.2	0.01	0.0128	0.0009



GRAVEL 1.7%	COARSE SAND 3.9%	MEDIUM SAND 6.4%	FINE SAND 40.3%	SILT OR CLAY 47.7%
BORING NO. MW-1 SS-16	DEPTH 32.0 to 34.0 ft.	CLASSIFICATION SC	REMARKS Sieve and Hydrometer Analysis	

PARTICLE SIZE DISTRIBUTION

DELL ENGINEERING
Environmental Consultants
HOLLAND, MICHIGAN 49423

Conestoga-Rovers & Associates, Inc.
Gold Shield Solvents
Grand Rapids, MI

JOB NO. 89300

DATE 6/8/89

SIEVE ANALYSIS

JOB NUMBER: 89300 DATE: 5/23/89

SAMPLE NUMBER: ~~MW-3~~ MW2 SS-1 DEPTH: 8.0 TO 10.0 FT.

SOIL SOURCE: GOLD SHIELD SOLVENTS - GRAND RAPIDS, MI

DESCRIPTION: REDDISH BROWN SANDY LEAN CLAY

CLASSIFICATION: CL

TECHNICIAN: RJT

LOSS BY WASHING

Pan Weight (gm).....	7.0	Weight of Soil Before Washing (gm)..	93.60
Pan and Dry Soil Weight (gm).....	100.6	Weight of Soil After Washing (gm)...	34.70
Drying Container (gm).....	120.2	Difference (gm).....	58.90
Drying Container and Dry Soil After Washing (gm).....	154.9	Percent Lost by Washing.....	62.93

SIEVE ANALYSIS

Sieve size	Sieve Weight	Sieve and Soil Weight	Weight Retained	% Retained	% Retained Cumulative	% Passing
#4	532.5	532.5	0.0	0.00	0.00	100.00
#10	456.3	457.4	1.1	1.18	1.18	98.82
#40	398.8	401.8	3.0	3.21	4.38	95.62
#100	422.5	438.3	15.8	16.88	21.26	78.74
#200	294.2	307.9	13.7	14.64	35.90	64.10
PAN	377.0	378.1	1.1	64.10	100.00	0.00
TOTAL	2481.3	2516.3	34.7	100.0	-	-

REMARKS: %GRAVEL = 0.00 %SAND = 35.90 %FINES = 64.10

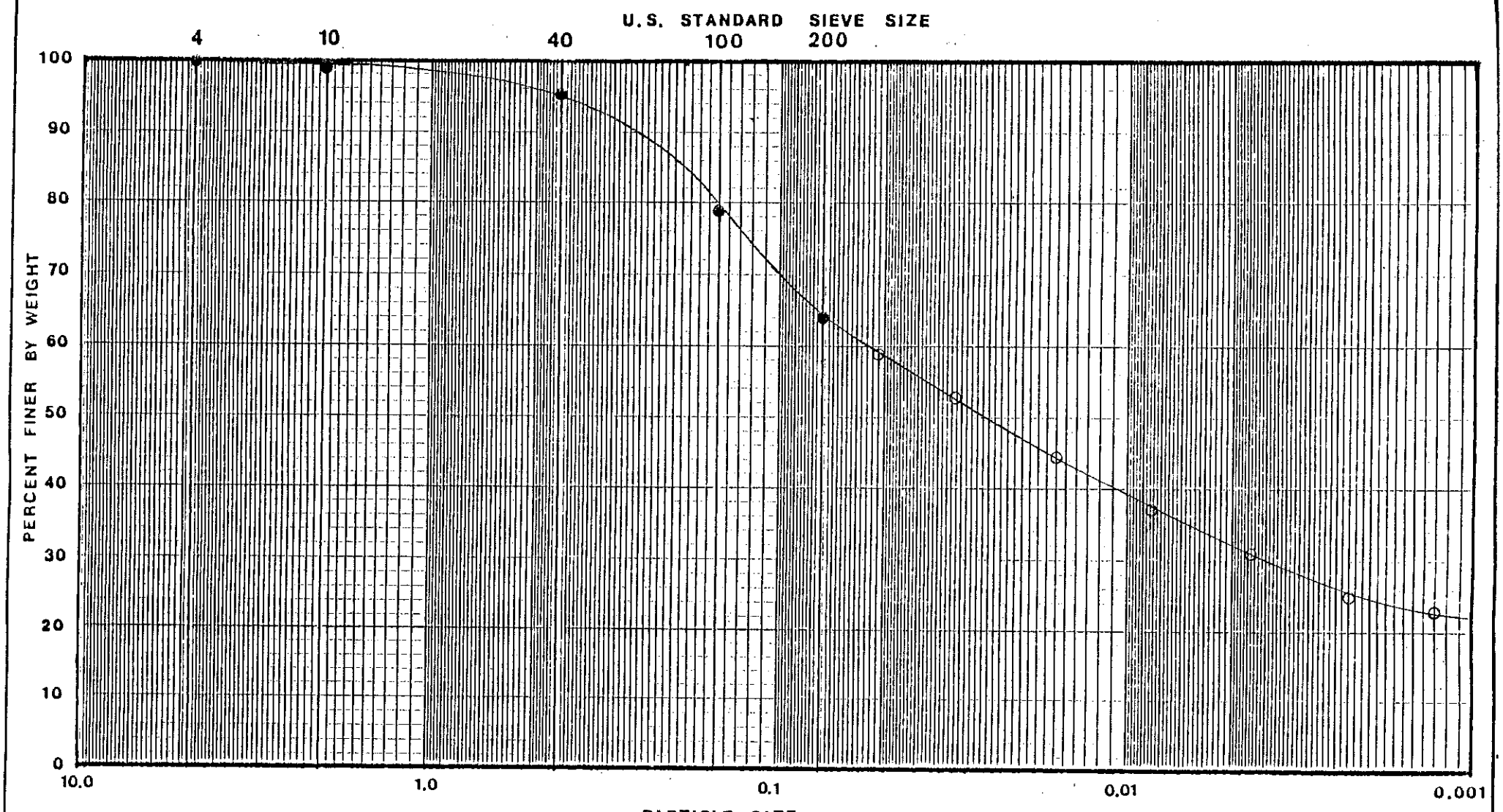
DELL ENGINEERING, INC.

GRAIN SIZE ANALYSIS - HYDROMETER METHOD

Project	CONESTOGA-ROVERS AND ASSOCIATES, INC.	Job Number	89300
Location of Project	GOLD SHIELD SOLVENTS - GRAND RAPIDS, MI	Sample Number	MW-3 SS-1
Description of soil	REDDISH BROWN SANDY LEAN CLAY (CL)	Depth of Sample	8.0 TO 10.0 FT.
Tested By	RJT	Date Tested	5/24/89 - 5/26/89

Specific Gravity	2.76
Specific Gravity Correction (a)	0.98
Zero Correction	2
Sample Weight (gm)	50

Date	Time	Elapsed Time(t)	T (C)	Actual Read(Ra)	Temp$ Corr(Ct)	Corr Read(Rc)	% Finer	Men. corr R	L*	L/t	K*	D(mm)
5/24/89	9:50	0	21.0	39.0	0.2	37.2	72.9	40.0	9.7	-	0.0131	
		0.25	21.0	34.0	0.2	32.2	63.1	35.0	10.6	42.24	0.0131	0.0851
		0.5	21.0	32.0	0.2	30.2	59.2	33.0	10.9	21.78	0.0131	0.0611
	9:51	1	21.0	30.3	0.2	28.5	55.9	31.3	11.2	11.17	0.0131	0.0438
	9:52	2	21.0	28.5	0.2	26.7	52.3	29.5	11.5	5.73	0.0131	0.0314
	9:54	4	21.0	27.0	0.2	25.2	49.4	28.0	11.7	2.93	0.0131	0.0224
	9:58	8	21.0	24.5	0.2	22.7	44.5	25.5	12.1	1.51	0.0131	0.0161
	10:05	15	21.0	22.9	0.2	21.1	41.4	23.9	12.4	0.83	0.0131	0.0119
	10:20	30	21.0	20.8	0.2	19.0	37.2	21.8	12.7	0.42	0.0131	0.0085
	10:50	60	21.0	19.1	0.2	17.3	33.9	20.1	13.0	0.22	0.0131	0.0061
	11:50	120	21.0	17.6	0.2	15.8	31.0	18.6	13.2	0.11	0.0131	0.0044
	13:50	240	22.0	16.0	0.4	14.4	28.2	17.0	13.5	0.06	0.0129	0.0031
	17:00	430	24.0	13.9	1.0	12.9	25.3	14.9	13.9	0.03	0.0126	0.0023
5/25/89	9:50	1440	23.0	13.0	0.7	11.7	22.9	14.0	14.0	0.01	0.0128	0.0013
5/26/89	14:30	3160	22.0	11.5	0.4	9.9	19.4	12.5	14.3	0.00	0.0129	0.0009



GRAVEL 0%	COARSE SAND 1.2%	MEDIUM SAND 3.2%	FINE SAND 31.5%	SILT OR CLAY 64.1%
BORING NO. MW-3 SS-1	DEPTH 8.0 to 10.0 ft.	CLASSIFICATION CL	REMARKS Sieve and Hydrometer Analysis	

PARTICLE SIZE DISTRIBUTION	DELL ENGINEERING Environmental Consultants HOLLAND, MICHIGAN 49423	Conestoga-Rovers & Associates, Inc. Gold Shield Solvents Grand Rapids, MI	NO. 89300 DATE 6/8/89

SIEVE ANALYSIS

JOB NUMBER: 89300 DATE: 5/18/89

SAMPLE NUMBER: MW-3 SS-6 DEPTH: 18.0 TO 20.0 FT.

SOIL SOURCE: GOLD SHIELD SOLVENTS - GRAND RAPIDS, MI

DESCRIPTION: LIGHT BROWN FINE TO MEDIUM GRAINED WELL GRADED SAND WITH SILT AND GRAVEL

CLASSIFICATION: SW-SM

TECHNICIAN: RJT

LOSS BY WASHING

Pan Weight (gm).....	6.9	Weight of Soil Before Washing (gm)..	118.80
Pan and Dry Soil Weight (gm).....	125.7	Weight of Soil After Washing (gm)...	111.20
Drying Container (gm).....	120.2	Difference (gm).....	7.60
Drying Container and Dry Soil After Washing (gm).....	231.4	Percent Lost by Washing.....	6.40

SIEVE ANALYSIS

Sieve size	Sieve Weight	Sieve and Soil Weight	Weight Retained	% Retained	% Retained Cumulative	% Passing
#4	532.5	585.8	53.3	44.87	44.87	55.13
#10	456.3	465.3	9.0	7.58	52.44	47.56
#40	398.8	412.0	13.2	11.11	63.55	36.45
#100	422.5	456.0	33.5	28.20	91.75	8.25
#200	294.2	296.3	2.1	1.77	93.52	6.48
PAN	377.0	378.4	0.1	6.48	100.00	0.00
TOTAL	2481.3	2593.8	111.2	100.0	-	-

REMARKS: %GRAVEL = 44.87 %SAND = 48.65 %FINES = 6.48

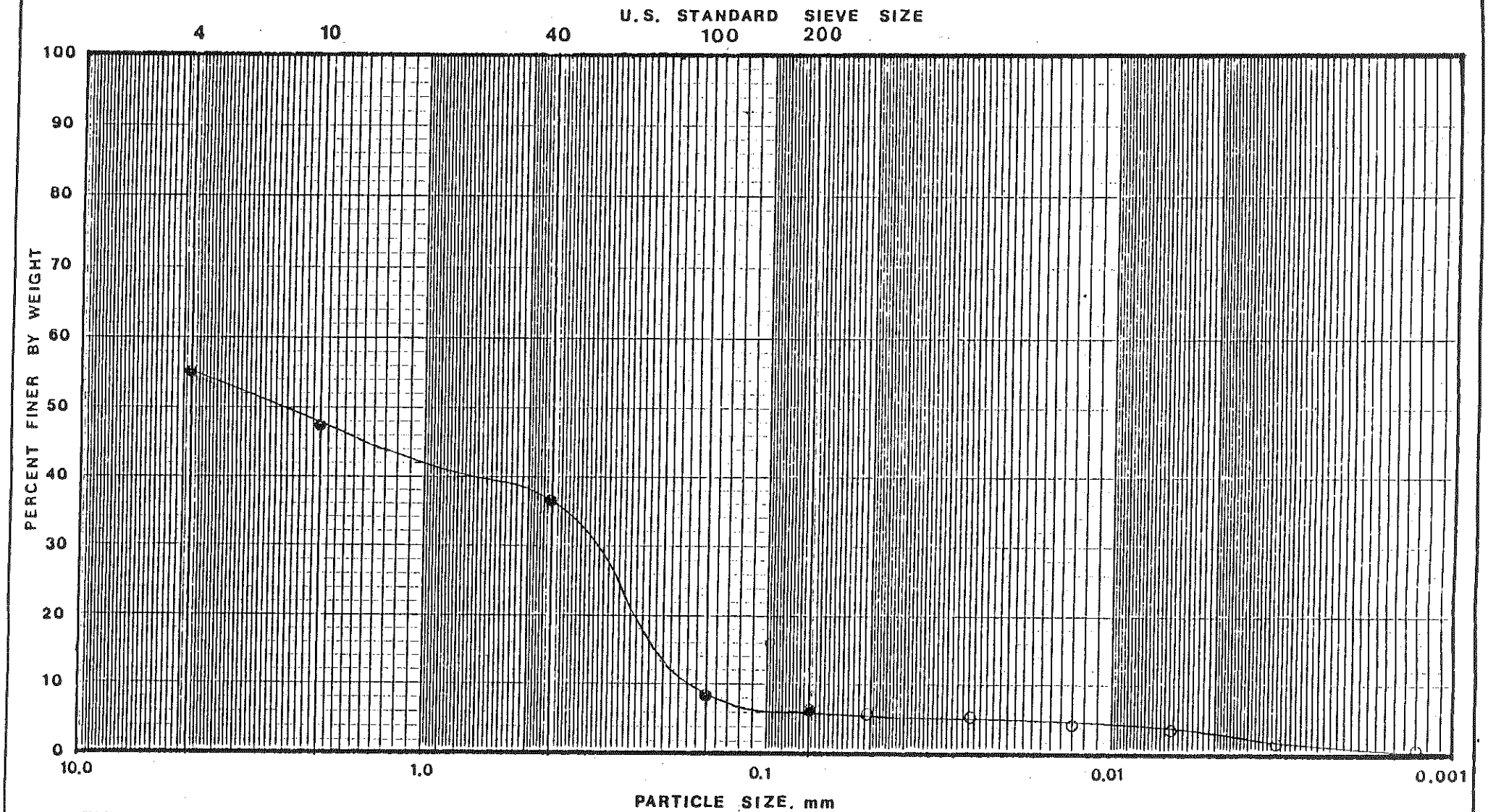
DELL ENGINEERING, INC.

GRAIN SIZE ANALYSIS - HYDROMETER METHOD

Project	CONESTOGA-ROVERS AND ASSOCIATES, INC.	Job Number	89300
Location of Project	GOLD SHIELD SOLVENTS - GRAND RAPIDS, MI	Sample Number	MW-3 SS-6
Description of soil	LT BROWN FINE TO MED. GRAINED WELL GRADED SAND WITH SILT AND GRAVEL (SW-SM)	Depth of Sample	18.0 TO 20.0 FT.
Tested By	RJT	Date Tested	6/5/89 - 6/7/89

Specific Gravity	2.73
Specific Gravity Correction (a)	0.98
Zero Correction	2
Sample Weight (gm)	50

Date	Time	Elapsed Time(t)	T (C)	Actual Read(Ra)	Temp± Corr(Ct)	Corr Read(Rc)	% Finer	Men. corr R	L±	L/t	K±	D(mm)
6/5/89	14:05	0	21.0	17.0	0.2	15.2	29.8	18.0	13.3	-	0.0131	
		0.25	21.0	10.0	0.2	8.2	16.1	11.0	14.5	57.98	0.0131	0.0998
		0.5	21.0	6.0	0.2	4.2	8.2	7.0	15.2	30.30	0.0131	0.0721
	14:06	1	21.0	5.0	0.2	3.2	6.3	6.0	15.3	15.32	0.0131	0.0513
	14:07	2	21.0	4.8	0.2	3.0	5.9	5.8	15.3	7.67	0.0131	0.0363
	14:09	4	21.0	4.5	0.2	2.7	5.3	5.5	15.4	3.85	0.0131	0.0257
	14:13	8	21.0	4.2	0.2	2.4	4.7	5.2	15.4	1.93	0.0131	0.0182
	14:20	15	21.0	4.0	0.2	2.2	4.3	5.0	15.5	1.03	0.0131	0.0133
	14:35	30	21.0	3.9	0.2	2.1	4.1	4.9	15.5	0.52	0.0131	0.0094
	15:05	60	21.0	3.7	0.2	1.9	3.7	4.7	15.5	0.26	0.0131	0.0067
	16:05	120	22.0	2.9	0.4	1.3	2.5	3.9	15.7	0.13	0.0130	0.0047
	18:05	240	22.0	2.2	0.4	0.6	1.2	3.2	15.8	0.07	0.0130	0.0033
	22:05	480	23.0	1.9	0.7	0.6	1.2	2.9	15.8	0.03	0.0128	0.0023
6/6/89	14:05	1440	23.0	1.7	0.7	0.4	0.8	2.7	15.9	0.01	0.0128	0.0013
6/7/89	14:05	2880	23.0	1.5	0.7	0.2	0.4	2.5	15.9	0.01	0.0128	0.0010



GRAVEL 44.9%	COARSE SAND 7.6%	MEDIUM SAND 11.1%	FINE SAND 29.9%	SILT OR CLAY 6.5%
BORING NO. MW-3 SS-6	DEPTH 18.0 to 20.0 ft.	CLASSIFICATION SW-SM	REMARKS Sieve and Hydrometer Analysis	

PARTICLE SIZE DISTRIBUTION	DELL ENGINEERING Environmental Consultants HOLLAND, MICHIGAN 49423	Conestoga-Rovers & Associates, Inc. Gold Shield Solvents Grand Rapids, MI	JOB NO. 89300 DATE 6/8/89

SIEVE ANALYSIS

JOB NUMBER: 89300 DATE: 5/18/89

SAMPLE NUMBER: ~~MW-3~~ MW-2 SS-7 DEPTH: 20.0 TO 22.0 FT.

SOIL SOURCE: GOLD SHIELD SOLVENTS - GRAND RAPIDS, MI

DESCRIPTION: BROWN CLAYEY GRAVEL

CLASSIFICATION: GC

TECHNICIAN: RJT

LOSS BY WASHING

Pan Weight (gm).....	7.0	Weight of Soil Before Washing (gm)..	116.20
Pan and Dry Soil Weight (gm).....	123.2	Weight of Soil After Washing (gm)...	100.50
Drying Container (gm).....	120.1	Difference (gm).....	15.70
Drying Container and Dry Soil After Washing (gm).....	220.6	Percent Lost by Washing.....	13.51

SIEVE ANALYSIS

Sieve size	Sieve Weight	Sieve and Soil Weight	Weight Retained	% Retained	% Retained Cumulative	% Passing
#4	532.5	595.3	62.8	54.04	54.04	45.96
#10	456.3	466.2	9.9	8.52	62.56	37.44
#40	398.8	407.6	8.8	7.57	70.14	29.86
#100	422.5	437.5	15.0	12.91	83.05	16.95
#200	294.2	297.7	3.5	3.01	86.06	13.94
PAN	377.0	378.4	0.5	13.94	100.00	0.00
TOTAL	2481.3	2582.7	100.5	100.0	-	-

REMARKS: %GRAVEL = 54.04 %SAND = 32.01 %FINES = 13.94

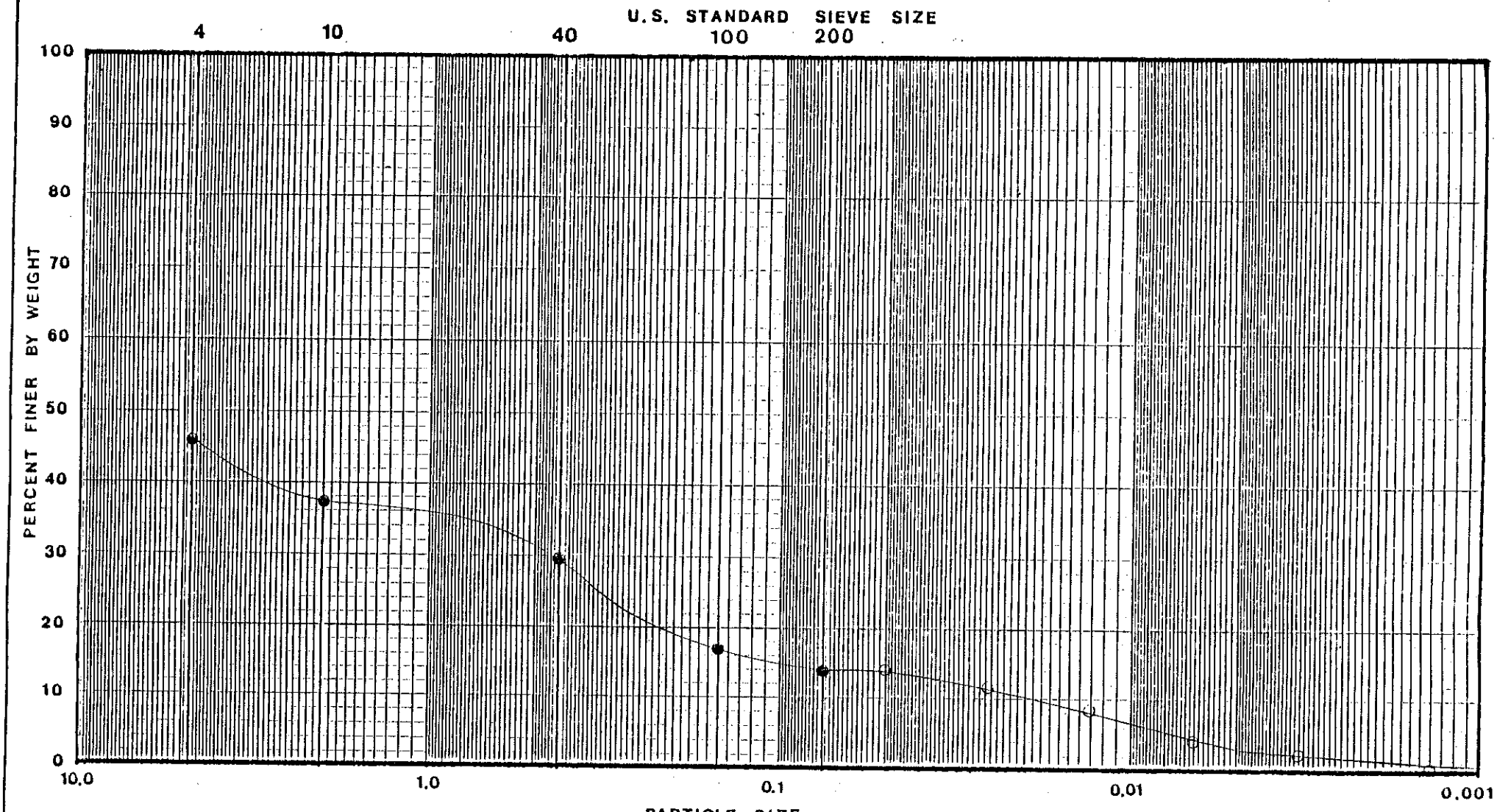
DELL ENGINEERING, INC.

GRAIN SIZE ANALYSIS - HYDROMETER METHOD

Project	CONESTOGA-ROVERS AND ASSOCIATES, INC.	Job Number	89300
Location of Project	GOLD SHIELD SOLVENTS - GRAND RAPIDS, MI	Sample Number	MW-3 SS-7
Description of soil	BROWN CLAYEY GRAVEL (GC)	Depth of Sample	20.0 TO 22.0 FT.
Tested By	RJT	Date Tested	5/30/89 - 6/1/89

Specific Gravity	2.68
Specific Gravity Correction (a)	0.99
Zero Correction	3
Sample Weight (gm)	50

Date	Time	Elapsed Time(t)	T (C)	Actual Read(Ra)	Temp& Corr(Ct)	Corr Read(Rc)	% Finer	Men. corr R	Lx	L/t	Kx	D(mm)
5/30/89	9:05	0	22.0	17.0	0.4	14.4	28.5	18.0	13.3	-	0.0131	
		0.25	22.0	13.0	0.4	10.4	20.6	14.0	14.0	56.02	0.0131	0.0980
		0.5	22.0	11.8	0.4	9.2	18.2	12.8	14.2	28.40	0.0131	0.0698
	9:06	1	22.0	10.0	0.4	7.4	14.7	11.0	14.5	14.50	0.0131	0.0499
	9:07	2	22.0	9.2	0.4	6.6	13.1	10.2	14.6	7.31	0.0131	0.0354
	9:09	4	22.0	8.5	0.4	5.9	11.7	9.5	14.7	3.69	0.0131	0.0251
	9:13	8	22.0	7.5	0.4	4.9	9.7	8.5	14.9	1.86	0.0131	0.0179
	9:20	15	22.0	6.9	0.4	4.3	8.5	7.9	15.0	1.00	0.0131	0.0131
	9:35	30	22.0	6.0	0.4	3.4	6.7	7.0	15.2	0.51	0.0131	0.0093
	10:05	60	22.0	4.9	0.4	2.3	4.6	5.9	15.3	0.26	0.0131	0.0066
	11:05	120	22.0	4.2	0.4	1.6	3.2	5.2	15.4	0.13	0.0131	0.0047
	13:05	240	23.0	3.5	0.7	1.2	2.4	4.5	15.6	0.06	0.0130	0.0033
	18:05	540	23.5	3.1	0.9	1.0	1.9	4.1	15.6	0.03	0.0129	0.0022
5/31/89	9:05	1440	22.0	2.9	0.4	0.3	0.6	3.9	15.7	0.01	0.0131	0.0014
6/1/89	14:25	3200	22.0	2.7	0.4	0.1	0.2	3.7	15.7	0.00	0.0131	0.0009



GRAVEL 54.0%	COARSE SAND 8.5%	MEDIUM SAND 7.6%	FINE SAND 15.9%	SILT OR CLAY 13.9%
BORING NO. MW-3 SS-7	DEPTH 20.0 to 22.0 ft.	CLASSIFICATION GC	REMARKS Sieve and Hydrometer Analysis	

PARTICLE SIZE DISTRIBUTION

DELL ENGINEERING
Environmental Consultants
HOLLAND, MICHIGAN 49423

Conestoga-Rovers & Associates, Inc.
Gold Shield Solvents
Grand Rapids, MI

NO. 89300

DATE 6/8/89

S I E V E A N A L Y S I S

JOB NUMBER: 89300 DATE: 5/18/89

SAMPLE NUMBER: ~~MW-4~~ MW3 SS-3 DEPTH: 4.0 TO 6.0 FT.

SOIL SOURCE: GOLD SHIELD SOLVENTS - GRAND RAPIDS, MI

DESCRIPTION: LIGHT BROWN FINE TO MEDIUM GRAINED POORLY GRADED SAND WITH SILT

CLASSIFICATION: SP-SM

TECHNICIAN: RJT

LOSS BY WASHING

Pan Weight (gm).....	7.0	Weight of Soil Before Washing (gm)..	102.80
Pan and Dry Soil Weight (gm).....	109.8	Weight of Soil After Washing (gm)...	97.70
Drying Container (gm).....	120.1	Difference (gm).....	5.10
Drying Container and Dry Soil After Washing (gm).....	217.8	Percent Lost by Washing.....	4.96

SIEVE ANALYSIS

Sieve size	Sieve Weight	Sieve and Soil Weight	Weight Retained	% Retained	% Retained Cumulative	% Passing
#4	532.5	538.0	5.5	5.35	5.35	94.65
#10	456.3	460.7	4.4	4.28	9.63	90.37
#40	398.8	430.5	31.7	30.84	40.47	59.53
#100	422.5	476.1	53.6	52.14	92.61	7.39
#200	294.2	296.6	2.4	2.33	94.94	5.06
PAN	377.0	378.4	0.1	5.06	100.00	0.00
TOTAL	2481.3	2580.3	97.7	100.0	-	-

REMARKS: %GRAVEL = 5.35 %SAND = 89.59 %FINES = 5.06

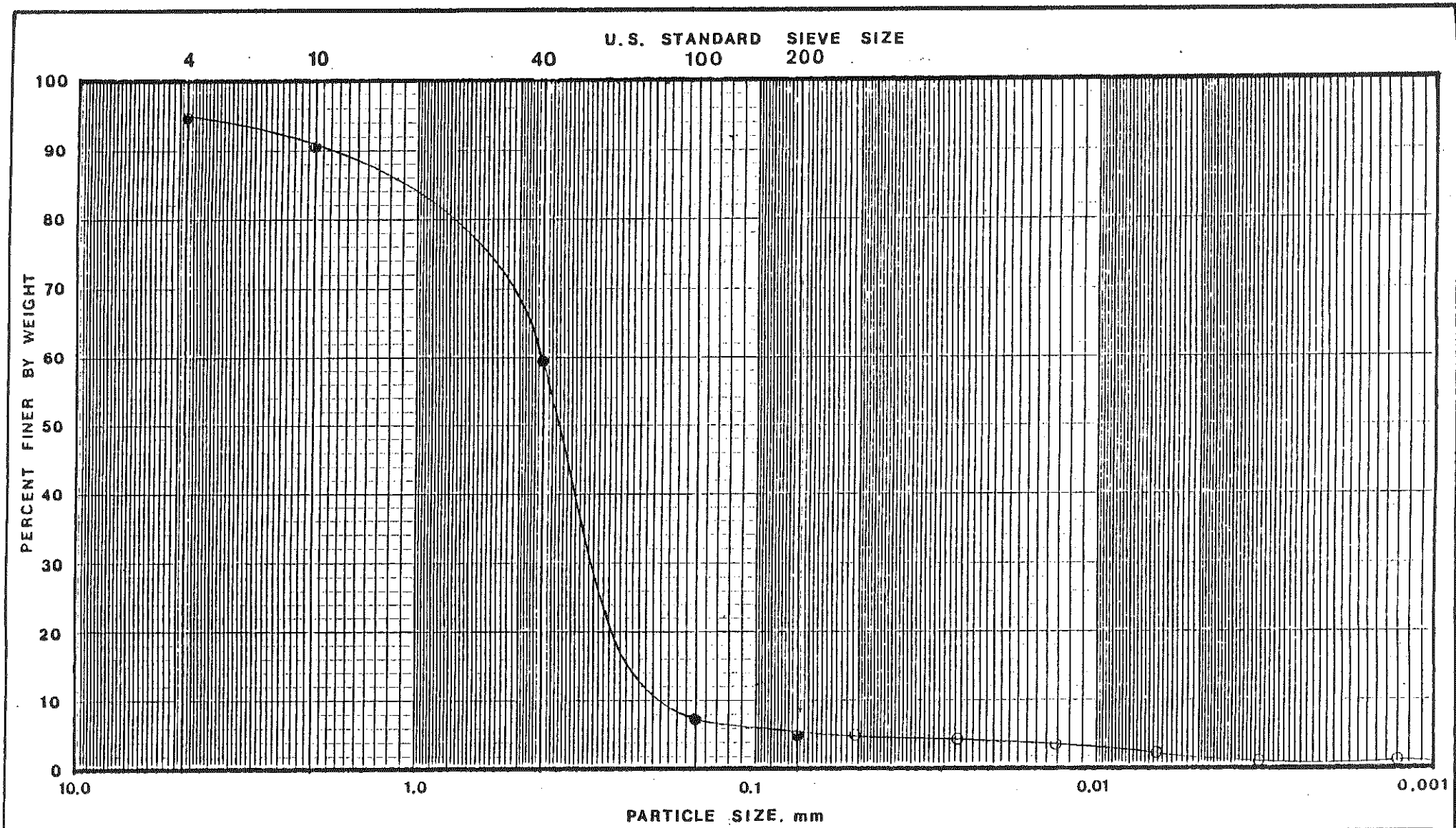
DELL ENGINEERING, INC.

GRAIN SIZE ANALYSIS - HYDROMETER METHOD

Project	CONESTOGA-ROVERS AND ASSOCIATES, INC.	Job Number	89300
Location of Project	GOLD SHIELD SOLVENTS - GRAND RAPIDS, MI	Sample Number	MW-4 SS-3
Description of soil	LT BROWN FINE TO MED. GRAINED SAND WITH SILT AND ORGANICS (SP-SM)	Depth of Sample	4.0 TO 6.0 FT.
Tested By	RJT	Date Tested	6/5/89 - 6/7/89

Specific Gravity	2.68
Specific Gravity Correction (a)	0.99
Zero Correction	4
Sample Weight (gm)	50

Date	Time	Elapsed Time(t)	T (C)	Actual Read(Ra)	Temp± Corr(Ct)	Corr Read(Rc)	% Finer	Men. corr R	Lt	L/t	Kt	D(mm)
6/5/89	14:45	0	21.0	18.0	0.2	14.2	28.1	19.0	13.2	-	0.0131	
		0.25	21.0	10.0	0.2	6.2	12.3	11.0	14.5	57.98	0.0131	0.0998
		0.5	21.0	8.0	0.2	4.2	8.3	9.0	14.8	29.65	0.0131	0.0713
	14:46	1	21.0	6.5	0.2	2.7	5.3	7.5	15.1	15.07	0.0131	0.0509
	14:47	2	21.0	6.2	0.2	2.4	4.8	7.2	15.1	7.56	0.0131	0.0360
	14:49	4	21.0	6.0	0.2	2.2	4.4	7.0	15.2	3.79	0.0131	0.0255
	14:53	8	21.0	5.8	0.2	2.0	4.0	6.8	15.2	1.90	0.0131	0.0180
	15:00	15	21.0	5.7	0.2	1.9	3.8	6.7	15.2	1.01	0.0131	0.0132
	15:15	30	21.0	5.4	0.2	1.6	3.2	6.4	15.3	0.51	0.0131	0.0093
	15:45	60	21.0	5.1	0.2	1.3	2.6	6.1	15.3	0.25	0.0131	0.0066
	16:45	120	22.0	5.0	0.4	1.4	2.8	6.0	15.3	0.13	0.0130	0.0046
	18:45	240	22.0	4.1	0.4	0.5	1.0	5.1	15.5	0.06	0.0130	0.0033
	22:45	480	23.0	4.0	0.7	0.7	1.4	5.0	15.5	0.03	0.0128	0.0023
6/6/89	14:45	1440	23.0	3.9	0.7	0.6	1.2	4.9	15.5	0.01	0.0128	0.0013
6/7/89	14:45	2880	23.0	3.8	0.7	0.5	1.0	4.8	15.5	0.01	0.0128	0.0009



GRAVEL 5.3%	COARSE SAND 4.3%	MEDIUM SAND 30.8%	FINE SAND 54.5%	SILT OR CLAY 5.1%
BORING NO. MW-4 SS-3	DEPTH 4.0 to 6.0 ft	CLASSIFICATION SP-SM	REMARKS Sieve and Hydrometer Analysis	

PARTICLE SIZE DISTRIBUTION	DELL ENGINEERING Environmental Consultants HOLLAND, MICHIGAN 49423	Conestoga-Rovers & Associates, Inc. Gold Shield Solvents Grand Rapids, MI	JOB NO. 89300 DATE 6/8/89

SIEVE ANALYSIS

JOB NUMBER: 89300 DATE: 5/23/89

SAMPLE NUMBER: ~~MW-4~~ MW3 SS-10 DEPTH: 18.0 TO 20.0 FT.

SOIL SOURCE: GOLD SHIELD SOLVENTS - GRAND RAPIDS, MI

DESCRIPTION: LIGHT BROWN FINE GRAINED POORLY GRADED SAND

CLASSIFICATION: SP

TECHNICIAN: RJT

LOSS BY WASHING

Pan Weight (gm).....	6.9	Weight of Soil Before Washing (gm)..	200.10
Pan and Dry Soil Weight (gm).....	207.0	Weight of Soil After Washing (gm)...	195.80
Drying Container (gm).....	120.1	Difference (gm).....	4.30
Drying Container and Dry Soil After Washing (gm).....	315.9	Percent Lost by Washing.....	2.15

SIEVE ANALYSIS

Sieve size	Sieve Weight	Sieve and Soil Weight	Weight Retained	% Retained	% Retained Cumulative	% Passing
#4	532.5	533.2	0.7	0.35	0.35	99.65
#10	456.3	456.5	0.2	0.10	0.45	99.55
#40	398.8	410.6	11.8	5.90	6.35	93.65
#100	422.5	600.3	177.8	88.86	95.20	4.80
#200	294.2	299.4	5.2	2.60	97.80	2.20
PAN	377.0	378.4	0.1	2.20	100.00	0.00
TOTAL	2481.3	2678.4	195.8	100.0	-	-

REMARKS: %GRAVEL = 0.35 %SAND = 97.45 %FINES = 2.20

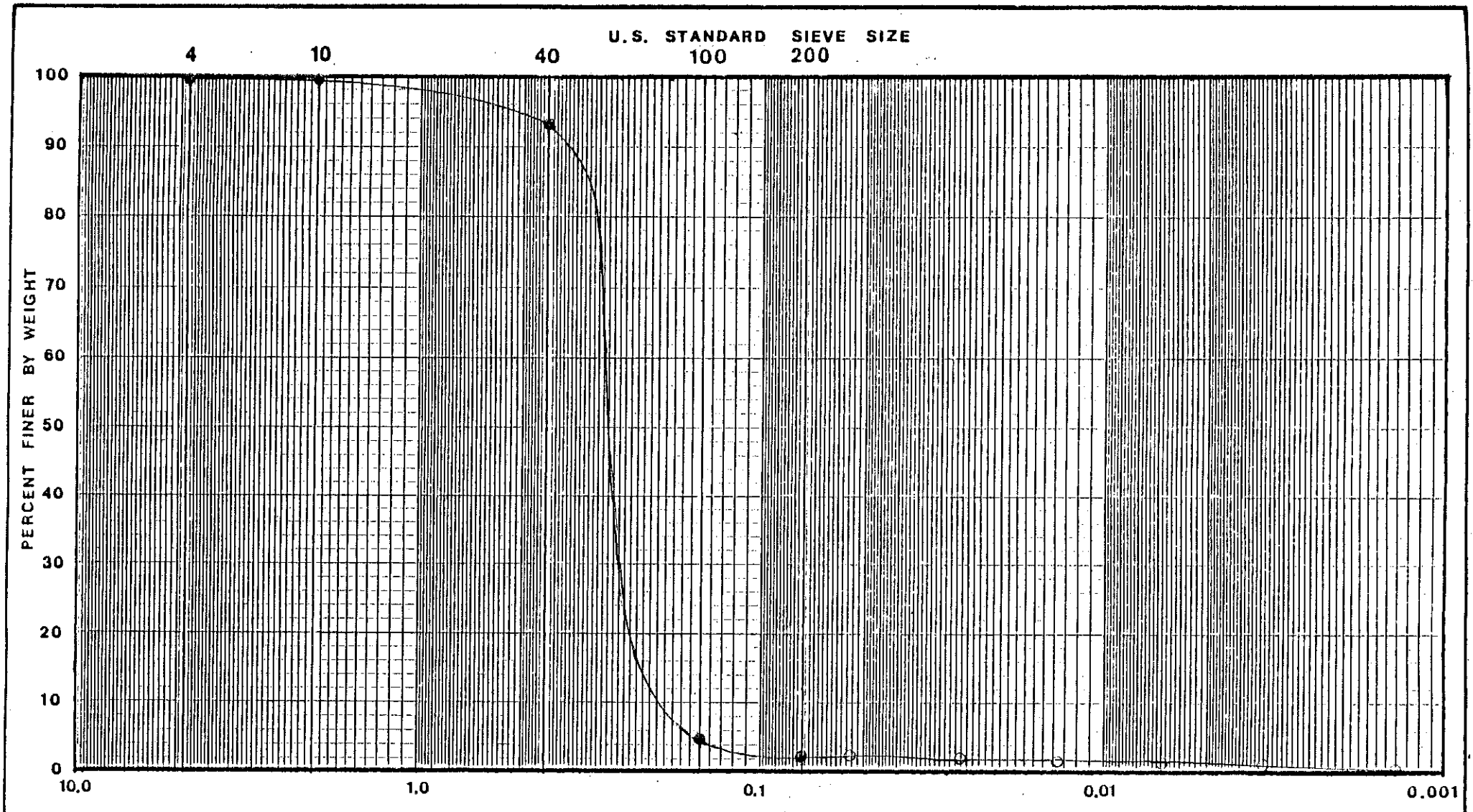
DELL ENGINEERING, INC.

GRAIN SIZE ANALYSIS - HYDROMETER METHOD

Project	CONESTOGA-ROVERS AND ASSOCIATES, INC.	Job Number	89300
Location of Project	GOLD SHIELD SOLVENTS - GRAND RAPIDS, MI	Sample Number	~~MW-4~~ SS-10
Description of soil	LT BROWN FINE GRAINED POORLY GRADED SAND(SP)	Depth of Sample	18.0 TO 20.0 FT.
Tested By	RJT	Date Tested	5/30/89 - 6/1/89

Specific Gravity	2.66
Specific Gravity Correction (a)	1.00
Zero Correction	4
Sample Weight (gm)	50

Date	Time	Elapsed Time(t)	T (C)	Actual Read(Ra)	Temp* Corr(Ct)	Corr Read(Rc)	% Finer	Men. corr R	L*	L/t	K*	D(mm)
5/30/89	9:45	0	22.0	8.0	0.4	4.4	8.8	9.0	14.8	-	0.0133	
		0.25	22.0	6.0	0.4	2.4	4.8	7.0	15.2	60.61	0.0133	0.1035
		0.5	22.0	5.1	0.4	1.5	3.0	6.1	15.3	30.60	0.0133	0.0736
	9:46	1	22.0	5.0	0.4	1.4	2.8	6.0	15.3	15.32	0.0133	0.0521
	9:47	2	22.0	4.9	0.4	1.3	2.6	5.9	15.3	7.67	0.0133	0.0368
	9:49	4	22.0	4.7	0.4	1.1	2.2	5.7	15.4	3.84	0.0133	0.0261
	9:53	8	22.0	4.6	0.4	1.0	2.0	5.6	15.4	1.92	0.0133	0.0184
	10:00	15	22.0	4.5	0.4	0.9	1.8	5.5	15.4	1.03	0.0133	0.0135
	10:15	30	22.0	4.4	0.4	0.8	1.6	5.4	15.4	0.51	0.0133	0.0095
	10:45	60	22.0	4.2	0.4	0.6	1.2	5.2	15.4	0.26	0.0133	0.0067
	11:45	120	22.0	4.0	0.4	0.4	0.8	5.0	15.5	0.13	0.0133	0.0048
	13:45	240	23.0	3.9	0.7	0.6	1.2	4.9	15.5	0.06	0.0132	0.0034
	18:05	500	23.5	3.8	0.9	0.6	1.3	4.8	15.5	0.03	0.0131	0.0023
5/31/89	10:15	1440	22.0	3.7	0.4	0.1	0.2	4.7	15.5	0.01	0.0133	0.0014
6/1/89	14:25	3160	22.0	3.6	0.4	0.0	0.0	4.6	15.5	0.00	0.0133	0.0009



GRAVEL 0.3%	COARSE SAND 0.1%	MEDIUM SAND 5.9%	FINE SAND 91.5%	SILT OR CLAY 2.2%
BORING NO. MW-4 SS-10	DEPTH 18.0 to 20.0 ft	CLASSIFICATION SP	REMARKS Sieve and Hydrometer Analysis	

PARTICLE SIZE DISTRIBUTION	DELL ENGINEERING Environmental Consultants HOLLAND, MICHIGAN 49423	Conestoga-Rovers & Associates, Inc. Gold Shield Solvents Grand Rapids, MI	J' NO. 89300 DATE 6/8/89

SIEVE ANALYSIS

JOB NUMBER: 89300 DATE: 5/19/89

SAMPLE NUMBER: ~~MW-4~~ MW3 SS-11 DEPTH: 20.0 TO 22.0 FT.

SOIL SOURCE: GOLD SHIELD SOLVENTS - GRAND RAPIDS, MI

DESCRIPTION: BROWN CLAYEY SAND

CLASSIFICATION: SC

TECHNICIAN: RJT

LOSS BY WASHING

Pan Weight (gm).....	6.8	Weight of Soil Before Washing (gm)..	154.00
Pan and Dry Soil Weight (gm).....	160.8	Weight of Soil After Washing (gm)...	123.20
Drying Container (gm).....	120.2	Difference (gm).....	30.80
Drying Container and Dry Soil After Washing (gm).....	243.4	Percent Lost by Washing.....	20.00

SIEVE ANALYSIS

Sieve size	Sieve Weight	Sieve and Soil Weight	Weight Retained	% Retained	% Retained Cumulative	% Passing
#4	532.5	536.0	3.5	2.27	2.27	97.73
#10	456.3	457.2	0.9	0.58	2.86	97.14
#40	398.8	406.1	7.3	4.74	7.60	92.40
#100	422.5	518.1	95.6	62.08	69.68	30.32
#200	294.2	308.5	14.3	9.29	78.96	21.04
PAN	377.0	378.4	1.6	21.04	100.00	0.00
TOTAL	2481.3	2604.3	123.2	100.0	-	-

REMARKS: %GRAVEL = 2.27 %SAND = 76.69 %FINES = 21.04

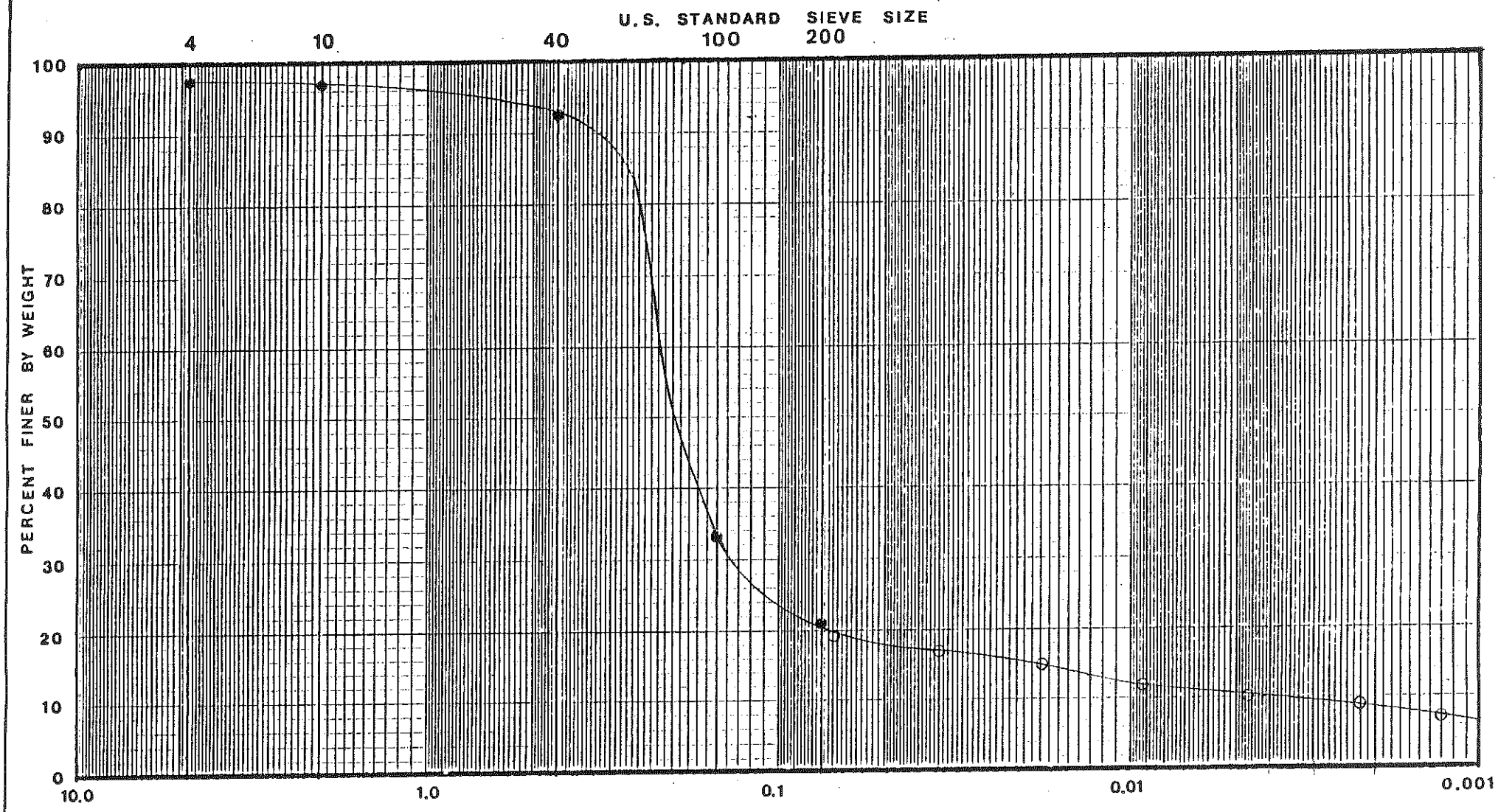
DELL ENGINEERING, INC.

GRAIN SIZE ANALYSIS - HYDROMETER METHOD

Project	CONESTOGA-ROVERS AND ASSOCIATES, INC.	Job Number	89300
Location of Project	GOLD SHIELD SOLVENTS - GRAND RAPIDS, MI	Sample Number	MW-4 SS-11
Description of soil	BROWN CLAYEY SAND (SC)	Depth of Sample	20.0 TO 22.0 FT.
Tested By	RJT	Date Tested	5/30/89 - 6/1/89

Specific Gravity	2.72
Specific Gravity Correction (a)	0.99
Zero Correction	3
Sample Weight (gm)	50

Date	Time	Elapsed Time(t)	T (C)	Actual Read(Ra)	Temp# Corr(Ct)	Corr Read(Rc)	% Finer	Men. corr R	L#	L/t	K#	D(mm)
5/30/89	9:50	0	22.0	20.0	0.4	17.4	34.5	21.0	12.9	-	0.0131	
		0.25	22.0	13.0	0.4	10.4	20.6	14.0	14.0	56.02	0.0131	0.0980
		0.5	22.0	12.3	0.4	9.7	19.2	13.3	14.1	28.24	0.0131	0.0696
	9:51	1	22.0	12.0	0.4	9.4	18.6	13.0	14.2	14.17	0.0131	0.0493
	9:52	2	22.0	11.2	0.4	8.6	17.0	12.2	14.3	7.15	0.0131	0.0350
	9:54	4	22.0	10.7	0.4	8.1	16.0	11.7	14.4	3.60	0.0131	0.0248
	9:58	8	22.0	10.2	0.4	7.6	15.0	11.2	14.5	1.81	0.0131	0.0176
	10:05	15	22.0	9.0	0.4	6.4	12.7	10.0	14.7	0.98	0.0131	0.0130
	10:20	30	22.0	8.6	0.4	6.0	11.9	9.6	14.7	0.49	0.0131	0.0092
	10:50	60	22.0	8.0	0.4	5.4	10.7	9.0	14.8	0.25	0.0131	0.0065
	11:50	120	22.0	7.7	0.4	5.1	10.1	8.7	14.9	0.12	0.0131	0.0046
	13:50	240	23.0	6.9	0.7	4.6	9.1	7.9	15.0	0.06	0.0130	0.0033
	18:05	495	23.5	6.6	0.9	4.4	8.8	7.6	15.1	0.03	0.0129	0.0022
5/31/89	9:50	1440	22.0	6.2	0.4	3.6	7.1	7.2	15.1	0.01	0.0131	0.0013
6/1/89	14:25	3155	22.0	5.5	0.4	2.9	5.7	6.5	15.2	0.00	0.0131	0.0009



GRAVEL 2.3%	COARSE SAND 0.6%	MEDIUM SAND 4.7%	FINE SAND 71.4%	SILT OR CLAY 21.0%
BORING NO. MW-4 SS-11	DEPTH 20.0 to 22.0 ft	CLASSIFICATION SC	REMARKS Sieve and Hydrometer Analysis	

PARTICLE SIZE DISTRIBUTION	DELL ENGINEERING Environmental Consultants HOLLAND, MICHIGAN 49423	Conestoga-Rovers & Associates, Inc. Gold Shield Solvents Grand Rapids, MI	JOB NO. 89300 DATE 6/8/89

SIEVE ANALYSIS

JOB NUMBER: 89300 DATE: 5/23/89

SAMPLE NUMBER: ~~MW-4~~ MW3 SS-14 DEPTH: 26.0 TO 28.0 FT.

SOIL SOURCE: GOLD SHIELD SOLVENTS - GRAND RAPIDS, MI

DESCRIPTION: BROWNISH GRAY LEAN CLAY WITH SAND

CLASSIFICATION: CL

TECHNICIAN: RJT

LOSS BY WASHING

Pan Weight (gm).....	7.0	Weight of Soil Before Washing (gm)..	128.80
Pan and Dry Soil Weight (gm).....	135.8	Weight of Soil After Washing (gm)...	33.20
Drying Container (gm).....	120.1	Difference (gm).....	95.60
Drying Container and Dry Soil After Washing (gm).....	153.3	Percent Lost by Washing.....	74.22

SIEVE ANALYSIS

Sieve size	Sieve Weight	Sieve and Soil Weight	Weight Retained	% Retained	% Retained Cumulative	% Passing
#4	532.5	532.8	0.3	0.23	0.23	99.77
#10	456.3	459.0	2.7	2.10	2.33	97.67
#40	398.8	404.2	5.4	4.19	6.52	93.48
#100	422.5	436.8	14.3	11.10	17.62	82.38
#200	294.2	304.3	10.1	7.84	25.47	74.53
PAN	377.0	378.4	0.4	74.53	100.00	0.00
TOTAL	2481.3	2515.5	33.2	100.0	-	-

REMARKS: %GRAVEL = 0.23 %SAND = 25.23 %FINES = 74.53

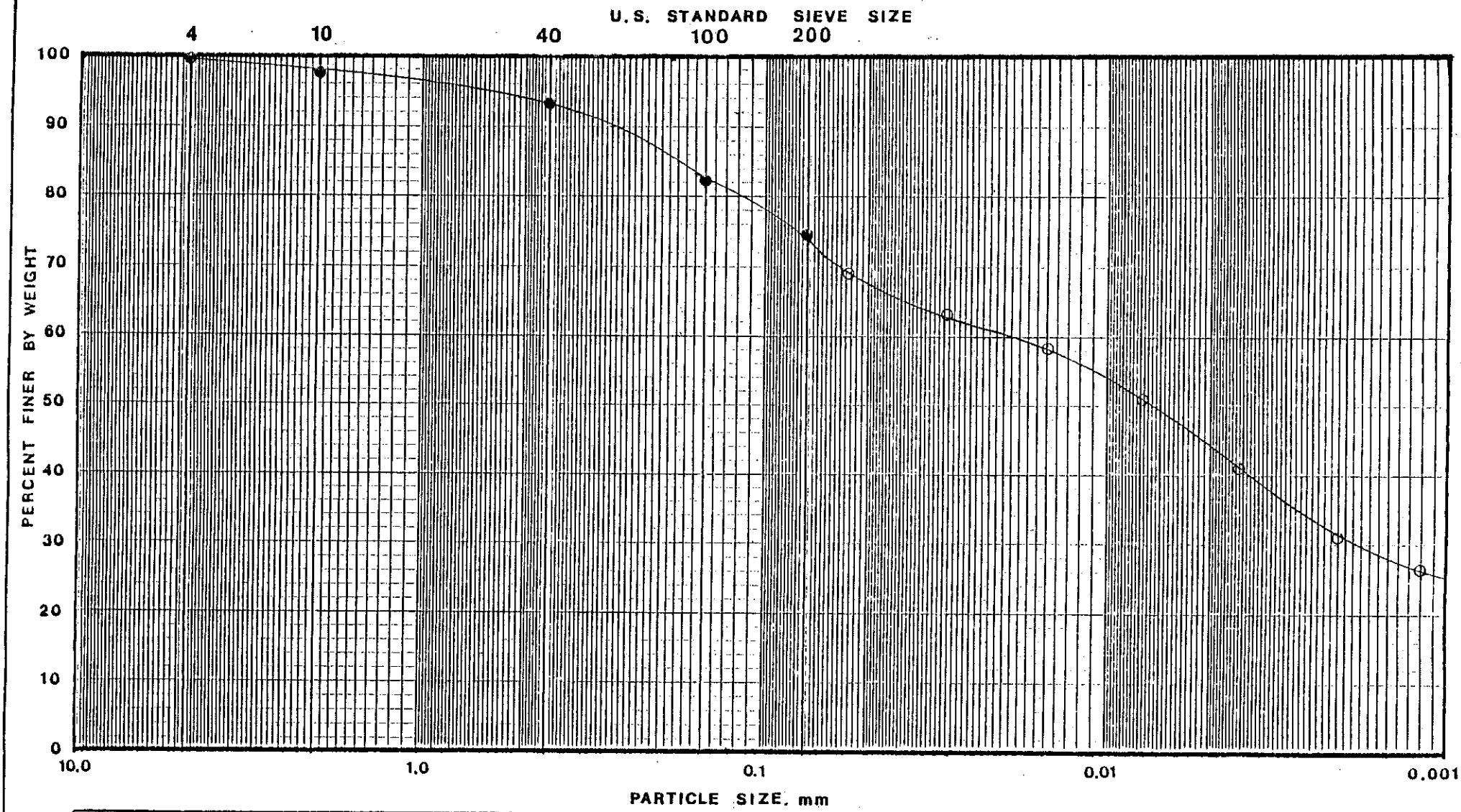
DELL ENGINEERING, INC.

GRAIN SIZE ANALYSIS - HYDROMETER METHOD

Project	CONESTOGA-ROVERS AND ASSOCIATES, INC.	Job Number	89300
Location of Project	GOLD SHIELD SOLVENTS - GRAND RAPIDS, MI	Sample Number	MW-4 SS-14
Description of soil	BROWNISH-GRAY LEAN CLAY WITH SAND (CL)	Depth of Sample	26.0 TO 28.0 FT.
Tested By	RJT	Date Tested	6/5/89 - 6/7/89

Specific Gravity	2.78
Specific Gravity Correction (a)	0.97
Zero Correction	3
Sample Weight (gm)	50

Date	Time	Elapsed Time(t)	T (C)	Actual Read(Ra)	Temp Corr(Ct)	Corr Read(Rc)	% Finer	Men. corr R	Lt	L/t	Kx	D(mm)
6/5/89	14:50	0	21.0	45.0	0.2	42.2	81.9	46.0	8.8	-	0.0129	
		0.25	21.0	40.0	0.2	37.2	72.2	41.0	9.6	38.30	0.0129	0.0798
		0.5	21.0	38.5	0.2	35.7	69.3	39.5	9.8	19.64	0.0129	0.0572
	14:51	1	21.0	37.0	0.2	34.2	66.3	38.0	10.1	10.07	0.0129	0.0409
	14:52	2	21.0	35.5	0.2	32.7	63.4	36.5	10.3	5.16	0.0129	0.0293
	14:54	4	21.0	35.0	0.2	32.2	62.5	36.0	10.4	2.60	0.0129	0.0208
	14:58	8	21.0	32.9	0.2	30.1	58.4	33.9	10.7	1.34	0.0129	0.0149
	15:05	15	21.0	30.8	0.2	28.0	54.3	31.8	11.1	0.74	0.0129	0.0111
	15:20	30	21.0	29.1	0.2	26.3	51.0	30.1	11.4	0.38	0.0129	0.0079
	15:50	60	21.0	26.8	0.2	24.0	46.6	27.8	11.7	0.20	0.0129	0.0057
	15:50	120	22.0	23.9	0.4	21.3	41.3	24.9	12.2	0.10	0.0128	0.0041
	18:50	240	22.0	20.5	0.4	17.9	34.7	21.5	12.8	0.05	0.0128	0.0030
	22:50	480	23.0	18.3	0.7	16.0	31.0	19.3	13.1	0.03	0.0126	0.0021
6/6/89	14:50	1440	23.0	16.1	0.7	13.8	26.8	17.1	13.5	0.01	0.0126	0.0012
6/7/89	14:50	2880	23.0	14.8	0.7	12.5	24.3	15.8	13.7	0.00	0.0126	0.0009



GRAVEL 0.2%	COARSE SAND 2.1%	MEDIUM SAND 4.2%	FINE SAND 18.9%	SILT OR CLAY 74.5%
BORING NO. MW-4 SS-14	DEPTH 26.0 to 28.0 ft.	CLASSIFICATION CL	REMARKS Sieve and Hydrometer Analysis	

PARTICLE SIZE DISTRIBUTION

DELL ENGINEERING
Environmental Consultants
HOLLAND, MICHIGAN 49423

Conestoga-Rovers & Associates, Inc.
Gold Shield Solvents
Grand Rapids, MI

JOB NO. 89300
DATE. 6/8/89

SIEVE ANALYSIS

JOB NUMBER: 89300 DATE: 5/23/89

SAMPLE NUMBER: ~~MW-2~~ BHA SS-2 DEPTH: 10.0 TO 12.0 FT.

SOIL SOURCE: GOLD SHIELD SOLVENTS - GRAND RAPIDS, MI

DESCRIPTION: BROWN WELL GRADED SAND WITH CLAY AND GRAVEL

CLASSIFICATION: SW-SC

TECHNICIAN: RJT

LOSS BY WASHING

Pan Weight (gm).....	7.0	Weight of Soil Before Washing (gm)..	123.50
Pan and Dry Soil Weight (gm).....	130.5	Weight of Soil After Washing (gm)...	111.10
Drying Container (gm).....	120.0	Difference (gm).....	12.40
Drying Container and Dry Soil After Washing (gm).....	231.1	Percent Lost by Washing.....	10.04

SIEVE ANALYSIS

Sieve size	Sieve Weight	Sieve and Soil Weight	Weight Retained	% Retained	% Retained Cumulative	% Passing
#4	532.5	590.5	58.0	46.96	46.96	53.04
#10	456.3	472.6	16.3	13.20	60.16	39.84
#40	398.8	411.6	12.8	10.36	70.53	29.47
#100	422.5	441.6	19.1	15.47	85.99	14.01
#200	294.2	298.9	4.7	3.81	89.80	10.20
PAN	377.0	378.4	0.2	10.20	100.00	0.00
TOTAL	2481.3	2593.6	111.1	100.0	-	-

REMARKS: %GRAVEL = 46.96 %SAND = 42.83 %FINES = 10.20

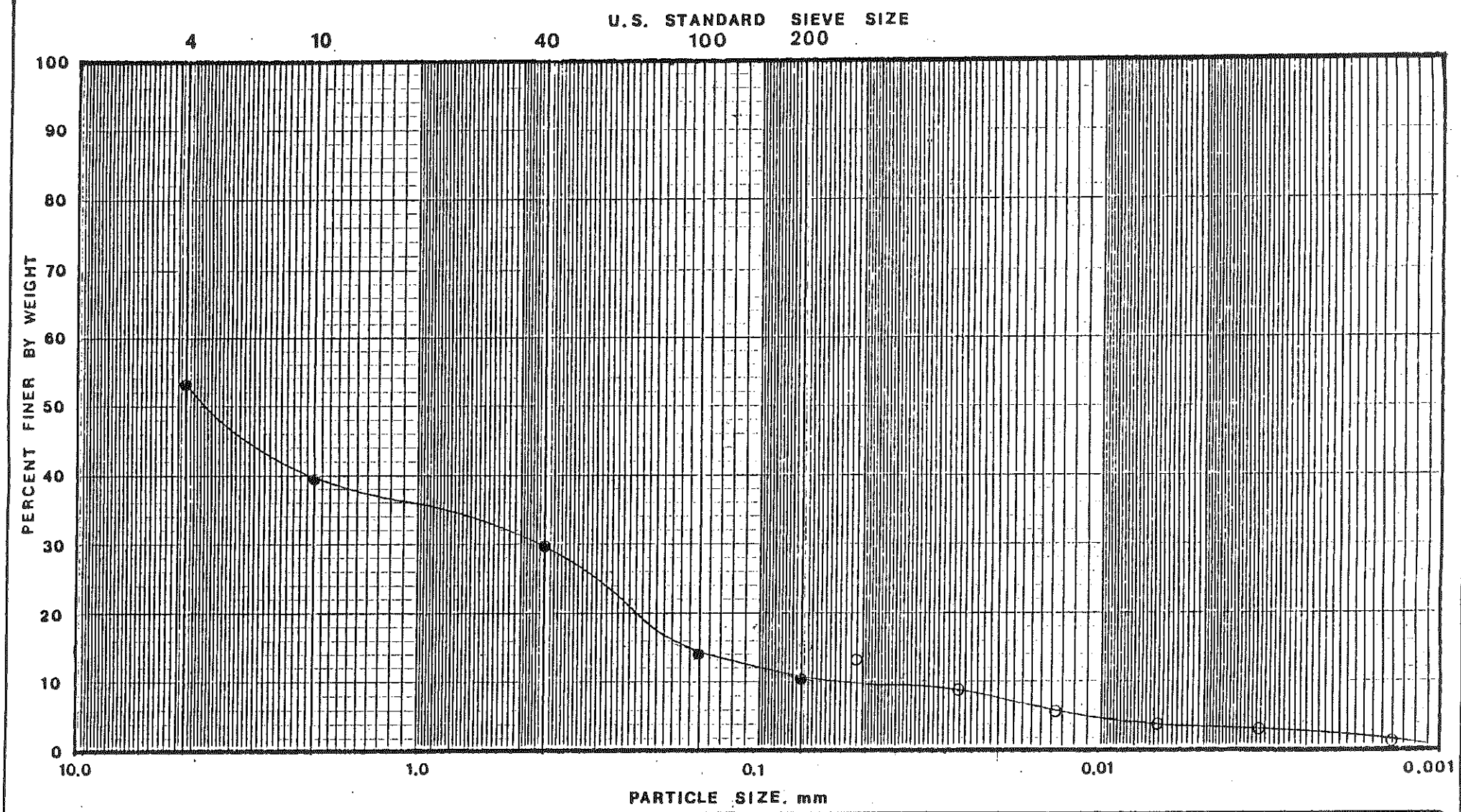
DELL ENGINEERING, INC.

GRAIN SIZE ANALYSIS - HYDROMETER METHOD

Project	CONESTOGA-ROVERS AND ASSOCIATES, INC.	Job Number	89300
Location of Project	GOLD SHIELD SOLVENTS - GRAND RAPIDS, MI	Sample Number	MW-2 SS-2
Description of soil	BROWN WELL GRADED SAND WITH CLAY AND GRAVEL (SW-SC)	Depth of Sample	10.0 TO 12.0 FT.
Tested By	RJT	Date Tested	5/30/89 - 6/1/89

Specific Gravity	2.67
Specific Gravity Correction (a)	1.00
Zero Correction	2
Sample Weight (gm)	50

Date	Time	Elapsed Time(t)	T (C)	Actual Read(Ra)	Tempt Corr(Ct)	Corr Read(Rc)	% Finer	Men. corr R	Lt	L/t	Kt	D(mm)
5/30/89	9:00	0	22.0	14.0	0.4	12.4	24.8	15.0	13.8	-	0.0133	
		0.25	22.0	10.5	0.4	8.9	17.8	11.5	14.4	57.66	0.0133	0.1010
		0.5	22.0	9.0	0.4	7.4	14.8	10.0	14.7	29.32	0.0133	0.0720
	9:01	1	22.0	8.1	0.4	6.5	13.0	9.1	14.8	14.81	0.0133	0.0512
	9:02	2	22.0	7.0	0.4	5.4	10.8	8.0	15.0	7.49	0.0133	0.0364
	9:04	4	22.0	6.1	0.4	4.5	9.0	7.1	15.1	3.78	0.0133	0.0259
	9:08	8	22.0	5.0	0.4	3.4	6.8	6.0	15.3	1.91	0.0133	0.0184
	9:15	15	22.0	4.5	0.4	2.9	5.8	5.5	15.4	1.03	0.0133	0.0135
	9:30	30	22.0	4.0	0.4	2.4	4.8	5.0	15.5	0.52	0.0133	0.0096
	10:00	60	22.0	3.5	0.4	1.9	3.8	4.5	15.6	0.26	0.0133	0.0068
	11:00	120	22.0	3.2	0.4	1.6	3.2	4.2	15.6	0.13	0.0133	0.0048
	13:00	240	23.0	2.9	0.7	1.6	3.2	3.9	15.7	0.07	0.0132	0.0034
	18:05	545	23.5	2.5	0.9	1.4	2.7	3.5	15.7	0.03	0.0131	0.0022
5/31/89	9:00	1440	22.0	2.0	0.4	0.4	0.8	3.0	15.8	0.01	0.0133	0.0014
6/1/89	14:25	3205	22.0	1.7	0.4	0.1	0.2	2.7	15.9	0.00	0.0133	0.0009



GRAVEL 46.9%	COARSE SAND 13.2%	MEDIUM SAND 10.4%	FINE SAND 19.3%	SILT OR CLAY 10.2%
BORING NO. MW-2 SS-2	DEPTH 10.0 to 12.0 ft.	CLASSIFICATION SW-SC	REMARKS Sieve and Hydrometer Analysis	

PARTICLE SIZE DISTRIBUTION	DELL ENGINEERING Environmental Consultants HOLLAND, MICHIGAN 49423	Conestoga-Rovers & Associates, Inc. Gold Shield Solvents Grand Rapids, MI	JOB NO. 89300 DATE 6/8/89

SIEVE ANALYSIS

JOB NUMBER: 89300 DATE: 5/23/89

SAMPLE NUMBER: ~~MW-2~~ BHA SS-6 DEPTH: 22.0 TO 24.0 FT.

SOIL SOURCE: GOLD SHIELD SOLVENTS - GRAND RAPIDS, MI

DESCRIPTION: BROWNISH GRAY LEAN CLAY WITH SAND

CLASSIFICATION: CL

TECHNICIAN: RJT

LOSS BY WASHING

Pan Weight (gm).....	7.0	Weight of Soil Before Washing (gm)..	133.70
Pan and Dry Soil Weight (gm).....	140.7	Weight of Soil After Washing (gm)...	41.70
Drying Container (gm).....	120.1	Difference (gm).....	92.00
Drying Container and Dry Soil After Washing (gm).....	161.8	Percent Lost by Washing.....	68.81

SIEVE ANALYSIS

Sieve size	Sieve Weight	Sieve and Soil Weight	Weight Retained	% Retained	% Retained Cumulative	% Passing
#4	532.5	536.0	3.5	2.62	2.62	97.38
#10	456.3	459.4	3.1	2.32	4.94	95.06
#40	398.8	405.7	6.9	5.16	10.10	89.90
#100	422.5	439.7	17.2	12.86	22.96	77.04
#200	294.2	304.9	10.7	8.00	30.96	69.04
PAN	377.0	378.4	0.3	69.04	100.00	0.00
TOTAL	2481.3	2524.1	41.7	100.0	-	-

REMARKS: %GRAVEL = 2.62 %SAND = 28.35 %FINES = 69.04

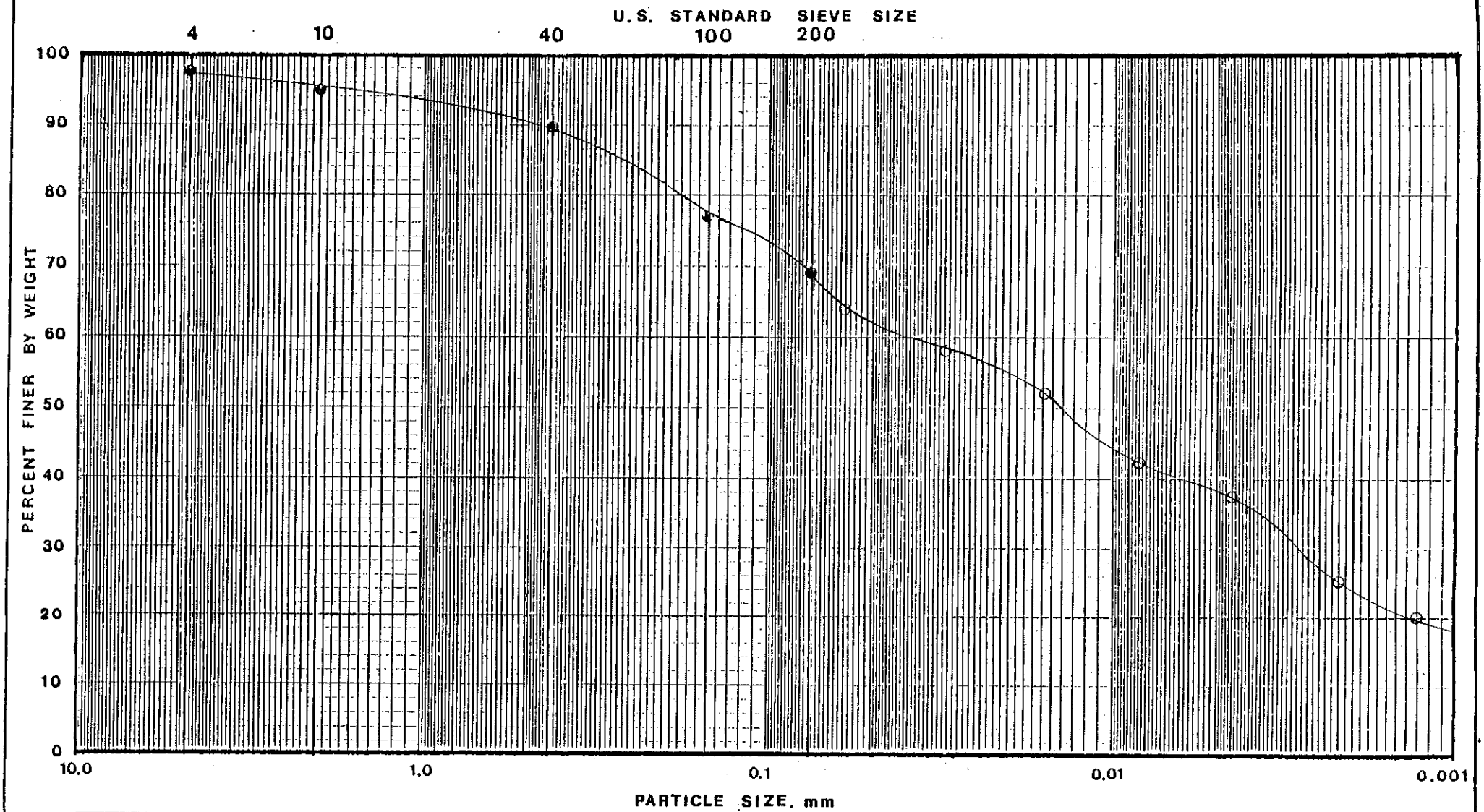
DELL ENGINEERING, INC.

GRAIN SIZE ANALYSIS - HYDROMETER METHOD

Project	CONESTOGA-ROVERS AND ASSOCIATES, INC.	Job Number	89300
Location of Project	GOLD SHIELD SOLVENTS - GRAND RAPIDS, MI	Sample Number	MW-2 SS-6
Description of soil	BROWNISH GRAY LEAN CLAY WITH SAND (CL)	Depth of Sample	22.0 TO 24.0 FT.
Tested By	RJT	Date Tested	6/2/89 - 6/5/89

Specific Gravity	2.74
Specific Gravity Correction (a)	0.98
Zero Correction	4
Sample Weight (gm)	50

Date	Time	Elapsed Time(t)	T (C)	Actual Read(Ra)	Temp* Corr(Ct)	Corr Read(Rc)	% Finer	Men. corr R	L*	L/t	K*	D(mm)
6/2/89	9:45	0	19.0	48.0	-0.3	43.7	85.7	49.0	8.3	-	0.0134	
		0.25	19.0	40.0	-0.3	35.7	70.0	41.0	9.6	38.30	0.0134	0.0829
		0.5	19.0	37.0	-0.3	32.7	64.1	38.0	10.1	20.14	0.0134	0.0601
	9:46	1	19.0	35.5	-0.3	31.2	61.2	36.5	10.3	10.31	0.0134	0.0430
	9:47	2	19.0	34.0	-0.3	29.7	58.2	35.0	10.6	5.28	0.0134	0.0308
	9:49	4	19.0	32.0	-0.3	27.7	54.3	33.0	10.9	2.72	0.0134	0.0221
	9:53	8	19.0	30.9	-0.3	26.6	52.1	31.9	11.1	1.38	0.0134	0.0158
	10:00	15	19.0	28.8	-0.3	24.5	48.0	29.8	11.4	0.76	0.0134	0.0117
	10:15	30	19.0	26.0	-0.3	21.7	42.5	27.0	11.9	0.40	0.0134	0.0084
	10:45	60	20.0	25.0	0.0	21.0	41.2	26.0	12.0	0.20	0.0133	0.0060
	11:35	110	20.0	23.0	0.0	19.0	37.2	24.0	12.4	0.11	0.0133	0.0045
	13:45	240	21.0	20.2	0.2	16.4	32.1	21.2	12.8	0.05	0.0131	0.0030
	17:45	480	22.0	16.5	0.4	12.9	25.3	17.5	13.4	0.03	0.0129	0.0022
6/3/89	10:15	1470	21.0	14.0	0.2	10.2	20.0	15.0	13.8	0.01	0.0131	0.0013
6/5/89	8:00	4215	20.0	12.9	0.0	8.9	17.4	13.9	14.0	0.00	0.0133	0.0008



GRAVEL 2.6%	COARSE SAND 2.3%	MEDIUM SAND 5.2%	FINE SAND 20.9%	SILT OR CLAY 69.0%
BORING NO. MW-2 SS-6	DEPTH 22.0 to 24.0 ft.	CLASSIFICATION CL	REMARKS Sieve and Hydrometer Analysis	

PARTICLE SIZE DISTRIBUTION	DELL ENGINEERING Environmental Consultants HOLLAND, MICHIGAN 49423	Conestoga-Roverts & Associates, Inc. Cold Shield Solvents Grand Rapids, MI	NO. 89300 DATE 6/8/89

DELL ENGINEERING, INC.
245 EAST LAKEWOOD BLVD.
HOLLAND, MI 49424-2066
PHONE 616-396-1296
FAX 616-396-7924

TRANSMITTAL

TO:
Conestoga-Rovers & Associates, Inc.
382 West County Road D
St. Paul, MN 55112

ATTN:
Jon Michels

DATE: 5-17-89

MAY 22 89

PROJECT:
Dell #89300

WE ARE TRANSMITTING _X_ HEREWITH ____ UNDER SEPARATE COVER

QUANTITY	DESCRIPTION
1 copy	Atterberg Limit Test results

ISSUED FOR ____ REVIEW & COMMENT ____ APPROVAL ____ INFORMATION
____ CONSTRUCTION _X_ YOUR FILE ____ AS REQUESTED

REMARKS

DISTRIBUTION
file

DELL ENGINEERING, INC.

BY: _____
R. Joseph Trojan
Geologist

ATTERBURG LIMIT TESTS (ASTM D4318-83)

(After: SEELYE, 1954 and American Society for Testing and Materials, 1985)

Purpose:
1. To classify soils.
2. To assign soils valued as foundation or construction material.
3. High values of liquid limit and plasticity index indicate high compressibility and low bearing capacity.
4. To determine soil suitability for road construction.

The liquid limit (LL) of a soil is the water content at which the groove formed in a soil sample with a standard grooving tool flows together for ½ inch along the groove with 25 blows of a mechanical liquid limit device.

$$LL = W_N \left(\frac{N}{25}\right)^{0.121}$$

Where: W_N = water content
N = number of blows to cause closure

The plastic limit (PL) is the lowest water content at which a thread of the soil can be just rolled to a diameter of 1/8 inch without cracking, crumbling, or breaking into pieces.

$$PL = \frac{\text{weight of water}}{\text{weight of oven dried soil}} \times 100$$

The plasticity index (PI) is the numerical difference between the liquid limit and the plastic limit.

$$PI = LL - PL$$

ATTERBERG LIMITS DETERMINATION

Project CRA - Gold Shield Solvents Job No. 89300

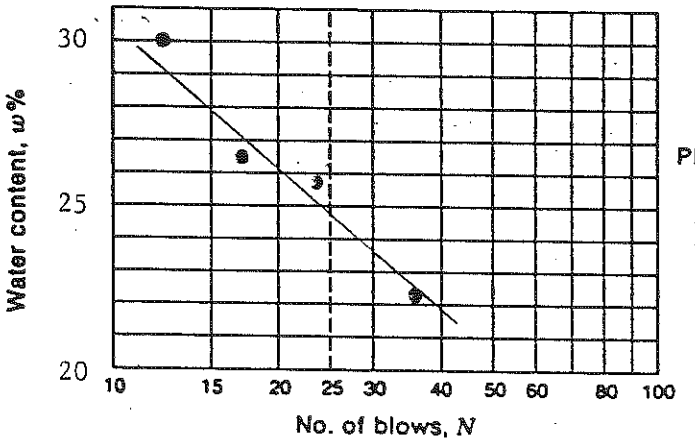
Location of Project Grand Rapids, MI Boring No. MW-1 Sample No. SS-2

Description of Soil Brown clayey sand with silt SC-SM

Depth of Sample 2-4' Tested By RJT Date 5-16-89

Liquid Limit Determination

Can no.	1	2	3	4		
Wt. of wet soil + can	16.0	12.9	15.1	16.7		
Wt. of dry soil + can	13.9	11.6	13.5	14.9		
Wt. of can	6.9	6.7	6.8	6.8		
Wt. of dry soil	7.0	4.9	6.2	8.1		
Wt. of moisture	2.1	1.3	1.6	1.8		
Water content, w%	30.0	26.5	25.8	22.2		
No. of blows, N	12.0	17.0	23.0	36.0		



Flow index F_f = _____

Liquid limit = 24.8

Plastic limit = 19.6

Plasticity index I_P = 5.2

ASTM Classification of Fines passing #40 sieve: CL-ML

Plastic Limit Determination

Can no.	1	2		
Wt. of wet soil + can	19.7	21.8		
Wt. of dry soil + can	19.3	21.0		
Wt. of can	16.5	16.5		
Wt. of dry soil	2.8	4.5		
Wt. of moisture	0.6	0.8	AVG	
Water content, w% = w_P	21.4	17.8	19.6	

ATTERBERG LIMITS DETERMINATION

Project CRA-Gold Shield Solvents Job No. 89300

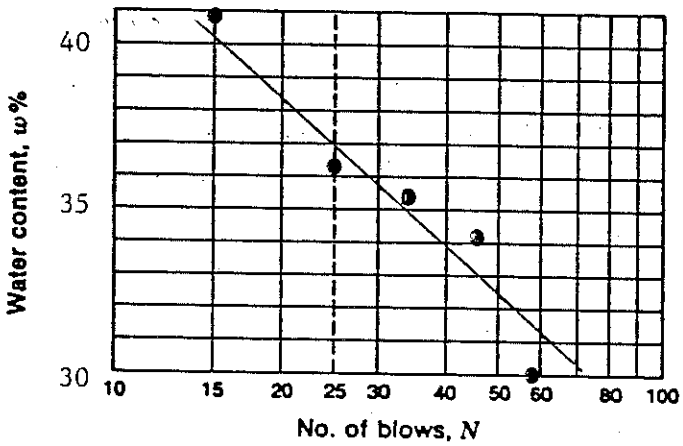
Location of Project Grand Rapids, MI Boring No. MW-1 Sample No. SS-4

Description of Soil Brown clayey sand SC

Depth of Sample 6-8' Tested By RJT Date 5-15-89

Liquid Limit Determination

Can no.	1	2	3	4	5	
Wt. of wet soil + can	16.1	15.8	16.0	18.8	16.1	
Wt. of dry soil + can	13.6	13.5	13.9	15.8	13.4	
Wt. of can	6.7	7.0	6.9	7.0	6.8	
Wt. of dry soil	6.9	6.5	7.0	8.8	6.6	
Wt. of moisture	2.5	2.3	2.1	3.0	2.7	
Water content, w%	36.2	35.3	30.0	34.1	40.9	
No. of blows, N	25.0	32.0	59.0	43.0	15.0	



Flow index F_i = ____

Liquid limit = 37.0

Plastic limit = 16.5

Plasticity index I_p = 20.5

ASTM Classification of Fines passing #40 sieve: CL

Plastic Limit Determination

Can no.	1	2		
Wt. of wet soil + can	19.6	20.4		
Wt. of dry soil + can	19.2	19.8		
Wt. of can	16.5	16.5		
Wt. of dry soil	2.9	3.3		
Wt. of moisture	0.4	0.6	AVG	
Water content, $w\% = w_p$	14.8	18.2	16.5	

ATTERBERG LIMITS DETERMINATION

Project CRA - Gold Shield Solvents Job No. 89300

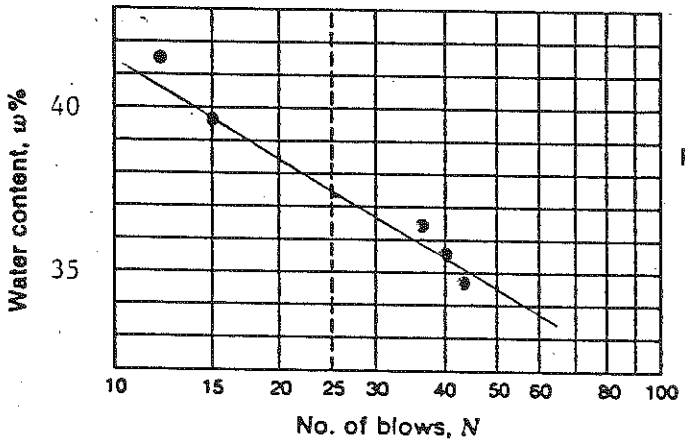
Location of Project Grand Rapids, MI Boring No. MW-1 Sample No. SS-10

Description of Soil Brownish -gray lean clay CL

Depth of Sample 20-22' Tested By RJT Date 5-16-89

Liquid Limit Determination

Can no.	1	2	3	4	5	
Wt. of wet soil + can	16.1	15.7	17.2	15.6	18.8	
Wt. of dry soil + can	13.4	13.3	14.3	13.3	15.7	
Wt. of can	6.9	6.7	7.0	6.7	7.0	
Wt. of dry soil	6.5	6.5	7.3	6.6	8.7	
Wt. of moisture	2.7	2.4	2.9	2.3	3.1	
Water content, w%	41.5	36.4	39.7	34.8	35.6	
No. of blows, N	12.0	36.0	15.0	42.0	40.0	



Flow index F_i = _____

Liquid limit = 37.2

Plastic limit = 16.5

Plasticity index I_p = 20.7

ASTM Classification of Fines passing #40 sieve: CL

Plastic Limit Determination

Can no.	1	2		
Wt. of wet soil + can	19.5	21.2		
Wt. of dry soil + can	19.1	20.5		
Wt. of can	16.5	16.5		
Wt. of dry soil	2.6	4.0		
Wt. of moisture	0.4	0.7	AVG	
Water content, $w\% = w_p$	15.4	17.5	16.5	

ATTERBERG LIMITS DETERMINATION

Project CRA - Gold Shield Solvents Job No. 89300

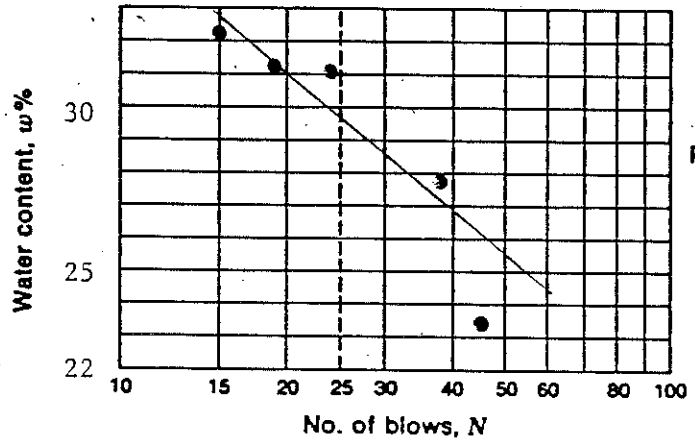
Location of Project Grand Rapids, MI Boring No. ~~MW-3~~ MW2 Sample No. SS-2

Description of Soil Brown sandy clay CL

Depth of Sample 10-12 ft. Tested By RJT Date 5-15-89

Liquid Limit Determination

Can no.	1	2	3	4	5	
Wt. of wet soil + can	16.9	15.7	17.1	20.3	17.6	
Wt. of dry soil + can	14.7	13.6	14.6	17.0	15.6	
Wt. of can	6.8	6.9	6.8	6.7	7.0	
Wt. of dry soil	7.9	6.7	7.8	10.3	8.6	
Wt. of moisture	2.2	2.1	2.5	3.2	2.0	
Water content, w%	27.8	31.3	32.1	31.1	23.3	
No. of blows, N	38.0	18.0	15.0	23.0	43.0	



Flow index F_i = _____

Liquid limit = 29.8

Plastic limit = 18.4

Plasticity index I_P = 11.4

ASTM Classifcation of Fines passing #40 sieve: CL

Plastic Limit Determination

Can no.	1	2		
Wt. of wet soil + can	21.2	22.1		
Wt. of dry soil + can	20.5	21.2		
Wt. of can	16.5	16.5		
Wt. of dry soil	4.0	4.7		
Wt. of moisture	0.7	0.9	AVG	
Water content, $w\% = w_P$	17.5	19.2	18.4	

ATTERBERG LIMITS DETERMINATION

Project CRA - Gold Shield Solvents Job No. 89300

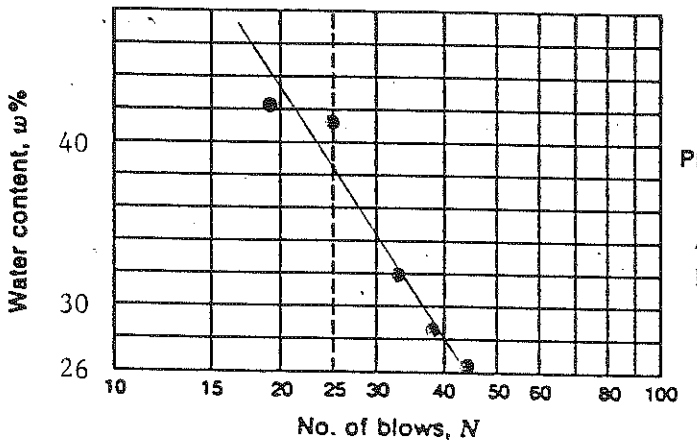
Location of Project Grand Rapids, MI Boring No. ~~MW-3~~ MW2 Sample No. SS-14

Description of Soil Brown sandy clay CL

Depth of Sample 38-40' Tested By RJT Date 5-16-89

Liquid Limit Determination

Can no.	1	2	3	4	5	
Wt. of wet soil + can	14.4	13.4	14.5	18.3	16.3	
Wt. of dry soil + can	12.8	11.8	12.8	15.0	13.5	
Wt. of can	6.8	6.8	6.9	7.0	6.9	
Wt. of dry soil	6.0	5.0	5.9	8.0	6.6	
Wt. of moisture	1.6	1.6	1.7	3.3	2.8	
Water content, w%	26.6	32.0	28.8	41.3	42.4	
No. of blows, N	43.0	32.0	38.0	25.0	19.0	



Flow index F_i = _____

Liquid limit = 39.2

Plastic limit = 20.9

Plasticity index I_P = 18.3

ASTM Classification of Fines passing #40 sieve: CL

Plastic Limit Determination

Can no.	1	2		
Wt. of wet soil + can	18.8	20.0		
Wt. of dry soil + can	18.4	19.4		
Wt. of can	16.5	16.5		
Wt. of dry soil	1.9	2.9		
Wt. of moisture	0.4	0.6	AVG	
Water content, $w\% = w_P$	21.1	20.7	20.9	

ATTERBERG LIMITS DETERMINATION

Project CRA-Gold Shield Solvents Job No. 89300

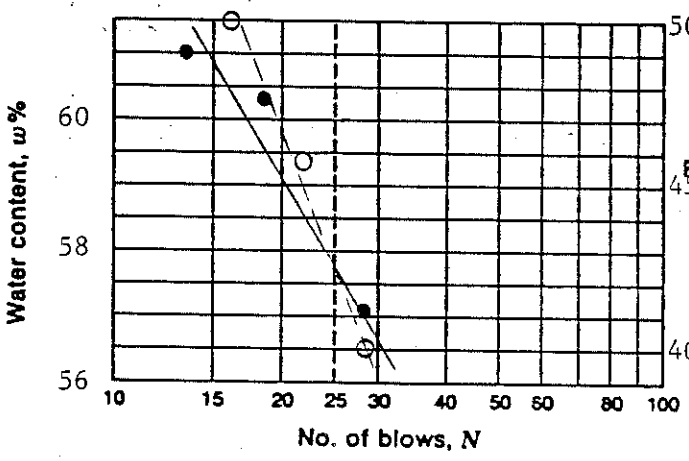
Location of Project Grand Rapids, MI Boring No. ~~MW-4~~ m Sample No. SS-4

Description of Soil Grayish-black organic silt with sand OH

Depth of Sample 6-8' Tested By RJT Date 5-17-89

Liquid Limit Determination

Can no.	1	2	3	1 oven-dried	2 oven-dried	3 oven-dried
Wt. of wet soil + can	19.3	14.6	19.1	19.4	18.7	18.8
Wt. of dry soil + can	14.6	11.7	14.7	15.2	15.0	15.4
Wt. of can	6.9	6.9	7.0	6.8	6.9	6.9
Wt. of dry soil	7.7	4.8	7.7	8.4	8.1	8.5
Wt. of moisture	4.7	2.9	4.4	4.2	3.7	3.4
Water content, w%	61.0	60.4	57.1	50.0	45.7	40.0
No. of blows, N	13.0	18.0	27.0	10.0	21.0	28.0



Flow index F_f = _____ Oven-Dried

Liquid limit = 57.7 42.3

Plastic limit = 46.7

Plasticity index I_P = 11.0

ASTM Classification of Fines passing #40 sieve: OH

○ LL oven-dried / ● LL air-dried < 0.75

Plastic Limit Determination

Can no.	1	2		
Wt. of wet soil + can	21.2	20.6		
Wt. of dry soil + can	19.7	19.3		
Wt. of can	16.5	16.5		
Wt. of dry soil	3.2	2.8		
Wt. of moisture	1.5	1.3	AVG	
Water content, $w\% = w_P$	46.9	46.4	46.7	

ATTERBERG LIMITS DETERMINATION

Project CRA- Gold Shield Solvents Job No. 89300

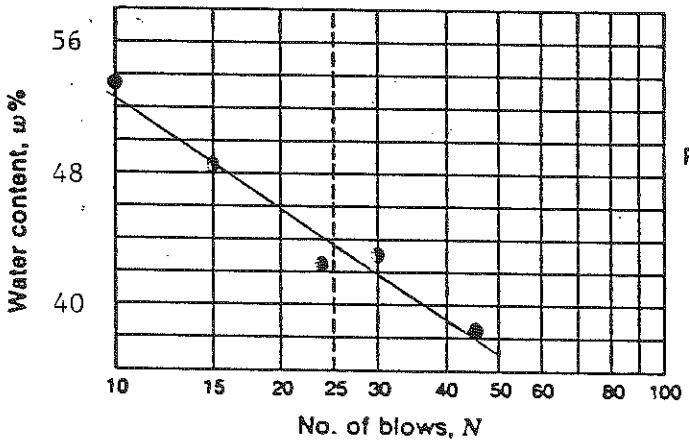
Location of Project Grand Rapids, MI Boring No. ~~MW-4~~ SS-15 Sample No. SS-15

Description of Soil Gray lean clay CL

Depth of Sample 28-30' Tested By RJT Date 5-17-89

Liquid Limit Determination

Can no.	1	2	3	4	5	
Wt. of wet soil + can	13.2	15.2	15.7	13.3	15.8	
Wt. of dry soil + can	11.1	12.7	13.1	11.0	13.3	
Wt. of can	6.8	6.9	7.0	6.7	6.8	
Wt. of dry soil	4.3	5.8	6.1	4.3	6.5	
Wt. of moisture	2.1	2.5	2.6	2.3	2.5	
Water content, w%	48.8	43.1	42.6	53.5	38.4	
No. of blows, N	15.0	30.0	24.0	10.0	45.0	



Flow index F_f = _____

Liquid limit = 43.8

Plastic limit = 23.6

Plasticity index I_P = 20.2

ASTM Classification of Fines passing #40 sieve: CL

Plastic Limit Determination

Can no.	1	2		
Wt. of wet soil + can	19.7	19.6		
Wt. of dry soil + can	19.1	19.0		
Wt. of can	16.5	16.5		
Wt. of dry soil	2.6	2.5		
Wt. of moisture	0.6	0.6	AVG	
Water content, $w\% = w_P$	23.1	24.0	23.6	

ATTERBERG LIMITS DETERMINATION

Project CRA - Gold Shield Solvents Job No. 89300

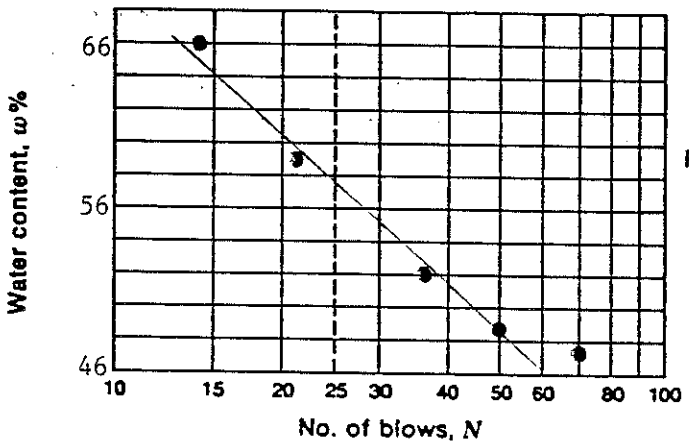
Location of Project Grand Rapids, MI Boring No. ~~MW-2~~ BHA Sample No. SS-3L C

Description of Soil Brown sandy fat clay with silt CH

Depth of Sample 14-16 ft. Tested By RJT Date 5-15-89

Liquid Limit Determination

Can no.	1	2	3	4	5	
Wt. of wet soil + can	14.9	15.7	15.5	15.8	14.1	
Wt. of dry soil + can	12.3	12.8	12.6	12.5	11.2	
Wt. of can	6.8	6.8	6.8	6.9	6.8	
Wt. of dry soil	5.5	6.0	5.8	5.6	4.4	
Wt. of moisture	2.6	2.9	2.9	3.3	2.9	
Water content, w%	47.3	48.3	50.0	59.0	66.0	
No. of blows, N	70.0	50.0	35.0	21.0	14.0	



Flow index F_i = _____

Liquid limit = 57.5

Plastic limit = 28.0

Plasticity index I_p = 29.5

ASTM Classification of Fines passing #40 sieve: CH

Plastic Limit Determination

Can no.	1	2		
Wt. of wet soil + can	19.9	19.1		
Wt. of dry soil + can	19.2	18.5		
Wt. of can	16.5	16.5		
Wt. of dry soil	2.7	2.0		
Wt. of moisture	0.7	0.6	AVG	
Water content, w% = w_p	25.9	30.0	28.0	

ATTERBERG LIMITS DETERMINATION

Project CRA-Gold Shield Solvents Job No. 89300

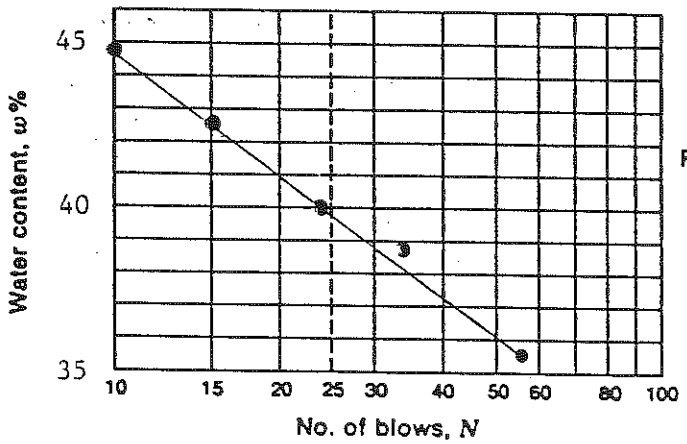
Location of Project Grand Rapids, MI Boring No. ~~SHA MW-2~~ Sample No. SS-7

Description of Soil Brownish-gray clay with sand CL

Depth of Sample 24-26' Tested By RJT Date 5-16-89

Liquid Limit Determination

Can no.	1	2	3	4	5	
Wt. of wet soil + can	15.0	13.5	17.0	18.2	16.8	
Wt. of dry soil + can	12.9	11.4	14.2	15.0	13.9	
Wt. of can	7.0	6.7	7.0	7.0	7.1	
Wt. of dry soil	5.9	4.7	7.2	8.0	6.8	
Wt. of moisture	2.1	2.1	2.8	3.2	2.9	
Water content, w%	35.6	44.7	38.9	40.0	42.7	
No. of blows, N	57.0	10.0	33.0	23.0	15.0	



Flow index F_I = _____

Liquid limit = 39.8

Plastic limit = 17.9

Plasticity index I_P = 21.9

ASTM Classification of Fines passing #40 sieve: CL

Plastic Limit Determination

Can no.	1	2		
Wt. of wet soil + can	19.7	19.9		
Wt. of dry soil + can	19.2	19.4		
Wt. of can	16.5	16.5		
Wt. of dry soil	2.7	2.9		
Wt. of moisture	0.5	0.5	AVG	
Water content, w% = w_P	18.5	17.2	17.9	

DELL ENGINEERING, INC.
245 EAST LAKEWOOD BLVD.
HOLLAND, MI 49424-2066
PHONE 616-396-1296
FAX 616-396-7924

TRANSMITTAL

TO:

CONESTOGA-ROVERS & ASSOC., INC.
382 WEST COUNTY ROAD D
ST. PAUL, MN 55112

ATTN:

DATE: 5-16-89

PROJECT: DELL #89300

MAY 17. 89

WE ARE TRANSMITTING X HEREWITH ____ UNDER SEPARATE COVER

QUANTITY	DESCRIPTION
1 copy	Moisture determination analysis results

ISSUED FOR ____ REVIEW & COMMENT ____ APPROVAL ____ INFORMATION
____ CONSTRUCTION X YOUR FILE ____ AS REQUESTED

REMARKS

DISTRIBUTION

file

DELL ENGINEERING, INC.

BY: R. Joseph Trojan

R. Joseph Trojan
Geologist

ASTM DETERMINATION OF MOISTURE CONTENT OF SOIL BY THE MICROWAVE OVEN METHOD

Summary of Method

A moist soil specimen is placed in a suitable container and its mass determined. It is then placed in a microwave oven, subjected to an interval of drying, and removed from the oven and its new mass determined. This procedure is repeated until the mass becomes nearly constant. The difference between the mass of the moist specimen and the dried specimen is used as the mass of water originally contained in the specimen. The water content is determined by dividing the mass of water by the dry mass of soil, multiplied by 100. For a given soil and sample size, the time to achieve a constant dry mass can be noted and used as a minimum drying time for subsequent tests using the same size specimen of the same soil.

DELL ENGINEERING, INC.

MOISTURE DETERMINATION OF SOILS

Project No.: 89300 Technician: R. Joe Trojan

Date: 5/12/89 Sheet 1 of 1

Soil Description: Poorly graded gravel with silt and sand GP-GM

Soil Source: MW-1 (SS-7) Depth: 12 to 14'

Test No.	Weight in Grams					
	Wet Soil & Can	Dry Soil & Can	Water	Can	Dry Soil	% Moisture
1	79.3	70.5	8.8	6.8	63.7	13.8
2	99.3	88.5	10.8	6.9	81.6	13.2
3	107.5	94.4	13.1	6.7	87.7	14.9
					AVG	14.0

07/0011

DELL ENGINEERING, INC.

MOISTURE DETERMINATION OF SOILS

Project No.: 89300 Technician: R. Joe Trojan

Date: 5/12/89 Sheet 1 of 1

Soil Description: Gray lean clay

Soil Source: MW-1 (SS-11) Depth: 22-24'

Test No.	Weight in Grams					
	Wet Soil & Can	Dry Soil & Can	Water	Can	Dry Soil	% Moisture
1	53.1	46.9	6.2	6.7	40.2	15.4
2	82.3	72.6	9.7	6.8	65.8	14.7
3	75.0	66.0	9.0	6.8	59.2	15.2
					AVG	15.1

07/0011

DELL ENGINEERING, INC.

MOISTURE DETERMINATION OF SOILS

Project No.: 89300 Technician: R. Joe Trojan

Date: 5/12/89 Sheet 1 of 1

Soil Description: Brownish gray sandy clay

Soil Source: MW-1 (SS-18) Depth: 36-38'

Test No.	Weight in Grams					
	Wet Soil & Can	Dry Soil & Can	Water	Can	Dry Soil	% Moisture
1	77.0	71.5	5.5	6.9	64.6	8.5
2	101.2	94.8	6.4	6.8	88.0	7.2
3	93.2	85.0	8.2	6.7	78.3	10.5
					AVG	8.7

07/0011

DELL ENGINEERING, INC.

MOISTURE DETERMINATION OF SOILS

Project No.: 89300 Technician: R. Joe Trojan

Date: 5/12/89 Sheet 1 of 1

Soil Description: Poorly graded gravel with silt & sand-saturated w/ product

Soil Source: MW-3 (SS-9) Depth: 26-28'

Test No.	Weight in Grams					
	Wet Soil & Can	Dry Soil & Can	Water	Can	Dry Soil	% Moisture
1	335.2	305.6	29.6	6.7	298.9	9.9

07/0011

DELL ENGINEERING, INC.

MOISTURE DETERMINATION OF SOILS

Project No.: 89300 Technician: R. Joe Trojan

Date: 5/12/89 Sheet 1 of 1

Soil Description: Brown clayey sand

Soil Source: ~~MW-3~~ (SS-3) Depth: 12-14'

Test No.	Weight in Grams					
	Wet Soil & Can	Dry Soil & Can	Water	Can	Dry Soil	% Moisture
1	58.7	53.3	5.4	6.8	46.5	11.6
2	59.2	53.3	5.9	6.9	46.4	12.1
3	67.4	60.4	7.0	6.9	53.5	13.1
					AVG	12.3

07/0011

DELL ENGINEERING, INC.

MOISTURE DETERMINATION OF SOILS

Project No.: 89300 Technician: R. Joe Trojan

Date: 5/12/89 Sheet 1 of 1

Soil Description: Dark blackish-gray organic clay

Soil Source: ~~MW-4~~ (SS-5) Depth: 8-10'

MW-3

Test No.	Weight in Grams					
	Wet Soil & Can	Dry Soil & Can	Water	Can	Dry Soil	% Moisture
1	48.0	41.7	6.3	7.0	34.9	18.1
2	65.5	56.3	9.2	7.0	49.3	18.7
3	66.6	55.2	11.4	6.8	48.4	23.6
					AVG	20.1

07/0011

DELL ENGINEERING, INC.

MOISTURE DETERMINATION OF SOILS

Project No.: 89300 Technician: R. Joe Trojan

Date: 5/12/89 Sheet 1 of 1

Soil Description: Gray lean clay

Soil Source: ~~MW-4~~ MW-2 (SS-16) Depth: 30-32'

Test No.	Weight in Grams					
	Wet Soil & Can	Dry Soil & Can	Water	Can	Dry Soil	% Moisture
1	59.4	50.5	8.9	6.9	43.6	20.4
2	78.9	66.4	12.5	6.9	59.5	21.0
3	60.3	50.8	9.5	6.9	43.9	21.6
					AVG	21.0

07/0011

DELL ENGINEERING, INC.

MOISTURE DETERMINATION OF SOILS

Project No.: 89300 Technician: R. Joe Trojan

Date: 5/12/89 Sheet 1 of 1

Soil Description: Brownish gray lean clay

Soil Source: ~~MW-2~~ (SS-9) Depth: 28-30'

B-1

Test No.	Weight in Grams					
	Wet Soil & Can	Dry Soil & Can	Water	Can	Dry Soil	% Moisture
1	56.4	51.1	5.3	6.9	44.2	12.0
2	54.5	49.4	5.1	6.9	42.5	12.0
3	77.9	70.2	7.7	6.9	63.3	12.2
					AVG	12.1

07/0011

APPENDIX C

CHEMICAL LABORATORY DATA REPORTS

2471

1938-1988
WADSWORTH/ALERT
LABORATORIES, INC.
Sampling, testing, mobile labs
4101 Shuffel Drive N.W. / North Canton, Ohio 44720

ANALYTICAL REPORT

PROJECT NO. 2471

DETREX-GOLD SHIELDS

Presented to :

DAVE DEMPSEY

CONESTOGA ROVERS & ASSOCIATES, LTD.

WADSWORTH/ALERT LABORATORIES, INC.

Bryce A. Custer

Bryce Custer
Project Manager

Marvin W. Stephens, Ph.D.
Vice President & Corporate Technical Director

May 26, 1989

CORPORATE AND LABORATORY: North Canton, Ohio (216) 497-9396
LABORATORY: Cleveland, Ohio (216) 642-9151
LABORATORY: Bartow, Florida (813) 533-2150
SOUTHEAST REGIONAL OFFICE: Lexington, South Carolina (803) 957-6590
24-HOUR ALERT LINE: (216) 497-9338

WADSWORTH/ALERT
LABORATORIES, INC.

WADSWORTH/ALERT
LABORATORIES, INC.

NARRATIVE

The following report contains the analytical results for four solid samples submitted to Wadsworth/ALERT Laboratories, Inc. by Conestoga Rovers & Associates, LTD. from the Detrex-Gold Shields Site, project number 2471. The sample was received on May 10, 1989, according to documented sample acceptance procedures.

The sample was analyzed for volatile organic compounds in accordance with SW846[1] Method 8240 and for total petroleum hydrocarbons using a modified SW846 Method 8015.

[1]SW846. "Test Methods for Evaluating Solid Waste Physical/Chemical Methods," Third Edition, September, 1986.

WADSWORTH/ALERT
LABORATORIES, INC.

COMPANY: CONESTOGA ROVERS & ASSOCIATES, LTD.
LAB #: 5305-17544
MATRIX: SOLID

DATE RECEIVED: 5/10/89
DATE EXTRACTED: 5/11/89
DATE ANALYZED: 5/17/89

SAMPLE ID: SS 10 MW2 5-8-89

VOLATILE ORGANICS
TARGET COMPOUND LIST - GC/MS

Chloromethane	ND*	trans-1,3-Dichloropropene	ND
Bromomethane	ND*	Trichloroethene	2
Vinyl chloride	ND*	Dibromochloromethane	ND
Chloroethane	ND*	1,1,2-Trichloroethane	ND
Methylene chloride	ND	Benzene	ND
Acetone	ND**	cis-1,3-Dichloropropene	ND
Carbon disulfide	ND	2-Chloroethylvinylether	ND
1,1-Dichloroethene	ND	Bromoform	ND
1,1-Dichloroethane	ND	4-Methyl-2-pentanone	ND
1,2-Dichloroethene (Total)	2	2-Hexanone	ND
Chloroform	ND	Tetrachloroethene	1
1,2-Dichloroethane	ND	1,1,2,2-Tetrachloroethane	ND
2-Butanone	ND**	Toluene	4
1,1,1-Trichloroethane	1	Chlorobenzene	ND
Carbon tetrachloride	ND	Ethylbenzene	4
Vinyl acetate	ND**	Styrene	ND
Bromodichloromethane	ND	Total Xylenes	20
1,2-Dichloropropane	ND		

NOTE: ND (None Detected, lower detectable limit = 1 mg/kg) as rec'd
ND* (None Detected, lower detectable limit = 2 mg/kg) as rec'd
ND** (None Detected, lower detectable limit = 10 mg/kg) as rec'd
J (Detected, but below quantitation limit; quantitation suspect)
B (Compound detected in method blank associated with this sample)
-- (Not Analyzed)

SURROGATE RECOVERY:	**%**	**ACCEPTABLE LIMITS** WATER	SOLID
1,2-Dichloroethane-d4	101	(76-114)	(70-121)
Toluene-d8	99	(88-110)	(81-117)
Bromofluorobenzene	99	(86-115)	(74-121)

WADSWORTH/ALERT
LABORATORIES, INC.

COMPANY: CONESTOGA ROVERS & ASSOCIATES, LTD.
LAB #: 5305-17544
MATRIX: SOLID

DATE RECEIVED: 5/10/89
DATE EXTRACTED: 5/15/89
DATE ANALYZED: 5/19/89

SAMPLE ID: SS 10 MW2 5-8-89

SELECTED ORGANIC COMPOUNDS ANALYTICAL REPORT

PARAMETER	RESULT (mg/kg)	DETECTION LIMIT
Total Petroleum Hydrocarbons	98	10

NOTE: ND (None Detected)
J (Detected, but below quantitation limit; quantitation suspect)

WADSWORTH/ALERT
LABORATORIES, INC.

COMPANY: CONESTOGA ROVERS & ASSOCIATES, LTD.
LAB #: 5305-17545
MATRIX: SOLID

DATE RECEIVED: 5/10/89
DATE EXTRACTED: 5/11/89
DATE ANALYZED: 5/17/89

SAMPLE ID: SS 11 MW2 5-8-89

VOLATILE ORGANICS
TARGET COMPOUND LIST - GC/MS

Chloromethane	ND*	trans-1,3-Dichloropropene	ND
Bromomethane	ND*	Trichloroethene	8
Vinyl chloride	ND*	Dibromochloromethane	ND
Chloroethane	ND*	1,1,2-Trichloroethane	ND
Methylene chloride	ND	Benzene	ND
Acetone	ND**	cis-1,3-Dichloropropene	ND
Carbon disulfide	ND	2-Chloroethylvinylether	ND
1,1-Dichloroethene	ND	Bromoform	ND
1,1-Dichloroethane	ND	4-Methyl-2-pentanone	ND
1,2-Dichloroethene (Total)	4	2-Hexanone	ND
Chloroform	ND	Tetrachloroethene	4
1,2-Dichloroethane	ND	1,1,2,2-Tetrachloroethane	ND
2-Butanone	ND**	Toluene	8
1,1,1-Trichloroethane	3	Chlorobenzene	ND
Carbon tetrachloride	ND	Ethylbenzene	8
Vinyl acetate	ND**	Styrene	ND
Bromodichloromethane	ND	Total Xylenes	41
1,2-Dichloropropane	ND		

NOTE: ND (None Detected, lower detectable limit = 3 mg/kg) as rec'd
ND* (None Detected, lower detectable limit = 6 mg/kg) as rec'd
ND** (None Detected, lower detectable limit = 30 mg/kg) as rec'd
J (Detected, but below quantitation limit; quantitation suspect)
B (Compound detected in method blank associated with this sample)
-- (Not Analyzed)

SURROGATE RECOVERY:	**%**	**ACCEPTABLE LIMITS** WATER	SOLID
1,2-Dichloroethane-d4	94	(76-114)	(70-121)
Toluene-d8	104	(88-110)	(81-117)
Bromofluorobenzene	104	(86-115)	(74-121)

WADSWORTH/ALERT
LABORATORIES, INC.

COMPANY: CONESTOGA ROVERS & ASSOCIATES, LTD.
LAB #: 5305-17545
MATRIX: SOLID

DATE RECEIVED: 5/10/89
DATE EXTRACTED: 5/15/89
DATE ANALYZED: 5/19/89

SAMPLE ID: SS 11 MW2 5-8-89

SELECTED ORGANIC COMPOUNDS ANALYTICAL REPORT

PARAMETER	RESULT (mg/kg)	DETECTION LIMIT
Total Petroleum Hydrocarbons	200	10

NOTE: ND (None Detected)
J (Detected, but below quantitation limit; quantitation suspect)

WADSWORTH/ALERT
LABORATORIES, INC.

COMPANY: CONESTOGA ROVERS & ASSOCIATES, LTD.
LAB #: 5305-17546
MATRIX: SOLID

DATE RECEIVED: 5/10/8
DATE EXTRACTED: 5/11/89
DATE ANALYZED: 5/17/89

SAMPLE ID: SS 12 MW2 5-8-89

VOLATILE ORGANICS
TARGET COMPOUND LIST - GC/MS

Chloromethane	ND*	trans-1,3-Dichloropropene	ND
Bromomethane	ND*	Trichloroethene	2
Vinyl chloride	ND*	Dibromochloromethane	ND
Chloroethane	ND*	1,1,2-Trichloroethane	ND
Methylene chloride	ND	Benzene	ND
Acetone	ND**	cis-1,3-Dichloropropene	ND
Carbon disulfide	ND	2-Chloroethylvinylether	ND
1,1-Dichloroethene	ND	Bromoform	ND
1,1-Dichloroethane	ND	4-Methyl-2-pentanone	ND
1,2-Dichloroethene (Total)	ND	2-Hexanone	ND
Chloroform	ND	Tetrachloroethene	ND
1,2-Dichloroethane	ND	1,1,2,2-Tetrachloroethane	ND
2-Butanone	ND**	Toluene	ND
1,1,1-Trichloroethane	ND	Chlorobenzene	ND
Carbon tetrachloride	ND	Ethylbenzene	1
Vinyl acetate	ND**	Styrene	ND
Bromodichloromethane	ND	Total Xylenes	7
1,2-Dichloropropane	ND		

NOTE: ND (None Detected, lower detectable limit = 1 mg/kg) as rec'd
ND* (None Detected, lower detectable limit = 2 mg/kg) as rec'd
ND** (None Detected, lower detectable limit = 10 mg/kg) as rec'd
J (Detected, but below quantitation limit; quantitation suspect)
B (Compound detected in method blank associated with this sample)
-- (Not Analyzed)

SURROGATE RECOVERY:	**%**	**ACCEPTABLE LIMITS** WATER	SOLID
1,2-Dichloroethane-d4	102	(76-114)	(70-121)
Toluene-d8	104	(88-110)	(81-117)
Bromofluorobenzene	105	(86-115)	(74-121)

WADSWORTH/ALERT
LABORATORIES, INC.

COMPANY: CONESTOGA ROVERS & ASSOCIATES, LTD.
LAB #: 5305-17546
MATRIX: SOLID

DATE RECEIVED: 5/10/89
DATE EXTRACTED: 5/15/89
DATE ANALYZED: 5/19/89

SAMPLE ID: SS 12 MW2 5-8-89

SELECTED ORGANIC COMPOUNDS ANALYTICAL REPORT

PARAMETER	RESULT (mg/kg)	DETECTION LIMIT
Total Petroleum Hydrocarbons	36	10

NOTE: ND (None Detected)
J (Detected, but below quantitation limit; quantitation suspect)

WADSWORTH/ALERT
LABORATORIES, INC.

COMPANY: CONESTOGA ROVERS & ASSOCIATES, LTD.
LAB #: 5305-17547
MATRIX: SOLID

DATE RECEIVED: 5/10/89
DATE EXTRACTED: 5/11/89
DATE ANALYZED: 5/17/89

SAMPLE ID: SS 13 MW2 5-8-89

VOLATILE ORGANICS
TARGET COMPOUND LIST - GC/MS

Chloromethane	ND*	trans-1,3-Dichloropropene	ND
Bromomethane	ND*	Trichloroethene	3
Vinyl chloride	ND*	Dibromochloromethane	ND
Chloroethane	ND*	1,1,2-Trichloroethane	ND
Methylene chloride	ND	Benzene	ND
Acetone	ND**	cis-1,3-Dichloropropene	ND
Carbon disulfide	ND	2-Chloroethylvinylether	ND
1,1-Dichloroethene	ND	Bromoform	ND
1,1-Dichloroethane	ND	4-Methyl-2-pentanone	ND
1,2-Dichloroethene (Total)	ND	2-Hexanone	ND
Chloroform	ND	Tetrachloroethene	ND
1,2-Dichloroethane	ND	1,1,2,2-Tetrachloroethane	ND
2-Butanone	ND**	Toluene	ND
1,1,1-Trichloroethane	ND	Chlorobenzene	ND
Carbon tetrachloride	ND	Ethylbenzene	ND
Vinyl acetate	ND**	Styrene	ND
Bromodichloromethane	ND	Total Xylenes	ND
1,2-Dichloropropane	ND		

NOTE: ND (None Detected, lower detectable limit = 1 mg/kg) as rec'd
ND* (None Detected, lower detectable limit = 2 mg/kg) as rec'd
ND** (None Detected, lower detectable limit = 10 mg/kg) as rec'd
J (Detected, but below quantitation limit; quantitation suspect)
B (Compound detected in method blank associated with this sample)
-- (Not Analyzed)

SURROGATE RECOVERY:	**%**	**ACCEPTABLE LIMITS** WATER	SOLID
1,2-Dichloroethane-d4	104	(76-114)	(70-121)
Toluene-d8	106	(88-110)	(81-117)
Bromofluorobenzene	109	(86-115)	(74-121)

WADSWORTH/ALERT
LABORATORIES, INC.

COMPANY: CONESTOGA ROVERS & ASSOCIATES, LTD.
LAB #: 5305-17547
MATRIX: SOLID

DATE RECEIVED: 5/10/89
DATE EXTRACTED: 5/15/89
DATE ANALYZED: 5/19/89

SAMPLE ID: SS 13 MW2 5-8-89

SELECTED ORGANIC COMPOUNDS ANALYTICAL REPORT

PARAMETER	RESULT (mg/kg)	DETECTION LIMIT
Total Petroleum Hydrocarbons	ND	10

NOTE: ND (None Detected)
J (Detected, but below quantitation limit; quantitation suspect)

WADSWORTH/ALERT
LABORATORIES, INC.

QUALITY CONTROL SECTION

WADSWORTH/ALERT
LABORATORIES, INC.

MATRIX SPIKE DATA

LAB ID	PARAMETER	SPIKE PERCENT RECOVERY	SPK/DUP PERCENT RECOVERY	SPIKE MATRIX	QC CONTROL LIMITS
	GC/MS VOLATILE COMPOUNDS				
890508	1,1-Dichloroethene	94	96	SOLID	(59-172)
	Trichloroethene	104	106		(62-137)
	Chlorobenzene	99	101		(60-133)
	Toluene	96	98		(59-139)
	Benzene	106	110		(66-142)

WADSWORTH/ALERT
LABORATORIES, INC.

MATRIX SPIKE DATA

LAB ID	PARAMETER	SPIKE PERCENT RECOVERY	SPK/DUP PERCENT RECOVERY	SPIKE MATRIX	QC CONTROL LIMITS
890512	Total Petroleum Hydrocarbons	90	50	SOLID	(25-119)

WADSWORTH/ALERT
LABORATORIES, INC.

CHECK SAMPLE DATA

LAB ID	PARAMETER	PERCENT RECOVERY	MATRIX	QC CONTROL LIMITS
	GC/MS VOLATILE COMPOUNDS			
92511	1,1-Dichloroethene	94	SOLID	(58-138)
	Trichloroethene	104		(79-127)
	Chlorobenzene	113		(83-130)
	Toluene	104		(74-127)
	Benzene	107		(74-135)

WADSWORTH/ALERT
LABORATORIES, INC.

CHECK SAMPLE DATA

LAB ID	PARAMETER	PERCENT RECOVERY	MATRIX	QC CONTROL LIMITS
92515	Total Petroleum Hydrocarbons	46	SOLID	(24-118)

WADSWORTH/ALERT
LABORATORIES, INC.

COMPANY: Wadsworth/Alert Laboratories
LAB #: 9289-92511
MATRIX: SOLID

DATE RECEIVED: 5/11/89
DATE EXTRACTED: 5/11/89
DATE ANALYZED: 5/16/89

SAMPLE ID: INTRA-LAB BLANK , 5 /11/89

VOLATILE ORGANICS
BLANK COMPOUND LIST - GC/MS

Acetone	ND**	1,1-Dichloroethane	ND
Acrolein	ND**	1,2-Dichloroethane	ND
Acrylonitrile	ND**	1,1-Dichloroethene	ND
2-Butanone	ND**	1,2-Dichloroethene (total)	ND
Benzene	ND	1,2-Dichloropropane	ND
Bromodichloromethane	ND	cis-1,3-Dichloropropene	ND
Bromoform	ND	trans-1,3-Dichloropropene	ND
Bromomethane	ND*	Ethylbenzene	ND
Carbon disulfide	ND	2-Hexanone	ND**
Carbon tetrachloride	ND	4-Methyl-2-pentanone	ND**
Chlorobenzene	ND	Methylene chloride	ND
Chloroethane	ND*	Styrene	ND
Chloroform	ND	1,1,2,2-Tetrachloroethane	ND
2-Chloroethyl vinyl ether	ND*	Tetrachloroethene	ND
Chloromethane	ND*	Toluene	ND
Chloromethyl methyl ether	ND	1,1,1-Trichloroethane	ND
Dibromochloromethane	ND	1,1,2-Trichloroethane	ND
1,2-Dichlorobenzene	ND	Trichloroethene	ND
1,3-Dichlorobenzene	ND	Trichlorofluoromethane	ND
1,4-Dichlorobenzene	ND	Vinyl acetate	ND**
Dichlorodifluoromethane	ND*	Vinyl chloride	ND*
		Total xylenes	ND

NOTE: ND (None Detected, lower detectable limit = 1 mg/kg) as rec'd
ND* (None Detected, lower detectable limit = 2 mg/kg) as rec'd
ND** (None Detected, lower detectable limit = 10 mg/kg) as rec'd
J (Detected , but below quantitation limit; quantitation suspect)
-- (Not Analyzed)

SURROGATE RECOVERY:	**%**	**ACCEPTABLE LIMITS** WATER	SOLID
1,2-Dichloroethane-d4	105	(76-114)	(70-121)
Toluene-d8	89	(88-110)	(81-117)
Bromofluorobenzene	89	(86-115)	(74-121)

WADSWORTH/ALERT
LABORATORIES, INC.

COMPANY: Wadsworth/Alert Laboratories
LAB #: 9289-92515
MATRIX: SOLID

DATE RECEIVED: 5/15/89
DATE EXTRACTED: 5/15/89
DATE ANALYZED: 5/19/89

SAMPLE ID: INTRA-LAB BLANK , 5 /15/89

SELECTED ORGANIC COMPOUNDS ANALYTICAL BLANK REPORT

PARAMETER	RESULT (mg/kg)	DETECTION LIMIT
Total Petroleum Hydrocarbons	ND	10

NOTE: ND (None Detected)

CRA Consulting Engineers
CONESTOGA-ROVERS & ASSOCIATES
651 Colby Drive, Waterloo, Ontario Canada N2V 1C2

SHIPPED TO (Laboratory name): Wadsworth - Alert Labs

CHAIN OF CUSTODY RECORD

PROJECT Nº: 2471

PROJECT NAME: Dethx - Celanese Chemicals

SAMPLER'S SIGNATURE: _____ (SIGN)

SEQ. Nº.	SAMPLE Nº.	DATE	TIME	SAMPLE LOCATOIN	SAMPLE TYPE	Nº OF CONTAINERS	REMARKS
	SS 10	5-8-89		MW 2	Sediment	1	TPH TCL VOC
	SS 11	5-8-89		MW 3	Sediment	1	TPH TCL VOC
	SS 12	5-8-89		MW 2	Sediment	1	TPH TCL VOC
	SS 13	5-8-89		MW 3	Sediment	1	TPH TCL VOC
				TOTAL NUMBER OF CONTAINERS			

ANTICIPATED CHEMICAL HAZARDS:

RELINQUISHED BY: 1 (SIGN)	DATE/TIME 5-9-89	RECEIVED BY: 2 (SIGN)
RELINQUISHED BY: 2 (SIGN)	DATE/TIME	RECEIVED BY: 3 (SIGN)
RELINQUISHED BY: 3 (SIGN)	DATE/TIME	RECEIVED BY: 4 (SIGN)
ADDITIONAL SIGNATURE SHEET REQUIRED ☐		

METHOD OF SHIPMENT:	SHIPPED BY:	RECEIVED FOR LABORATORY BY: (SIGN)	DATE/TIME 5/10/89 9:15 AM
CONDITION OF SEAL UPON RECEIPT: In Tact GENERAL CONDITION OF COOLER: Good		COOLER OPENED BY: (SIGN)	DATE/TIME 5/10/89 9:15 AM

WHITE – CRA OFFICE COPY
YELLOW – RECEIVING LABORATORY COPY
PINK – CRA LABORATORY COPY
GOLDEN ROD – SHIPPERS

5982

APPENDIX D

WELL RESPONSE TEST DATA

SINGLE WELL RESPONSE TEST - DATA AND CALCULATIONS
HVORSLEV METHOD (1951)

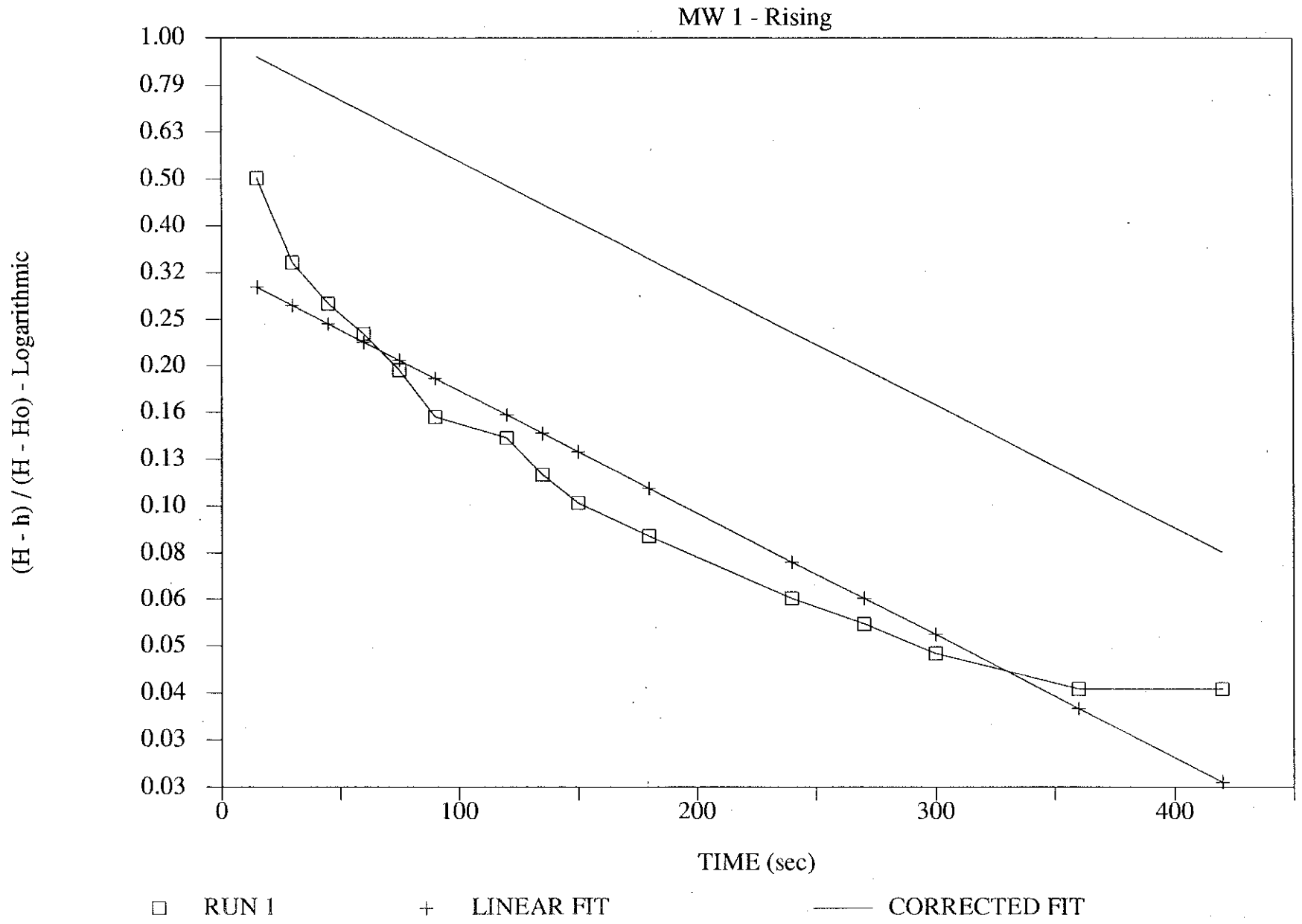
PROJECT NAME:	GOLD SHIELD SOLVENTS	HOLE DESIGNATION:	MW 1
PROJECT NUMBER:	2471	DATE TESTED:	5-12-89
CLIENT:	DETREX - GOLD SHIELD	TEST TYPE:	RISING
SUPERVISOR:	J. MICHAEL		

REF. ELEVATION:	m AMSL	WELL RADIUS (r):	0.025 m
STATIC DEPTH (H):	8.336 m	BOREHOLE RADIUS (R):	0.100 m
SLUG VOLUME:	0.773 L	SCREEN LENGTH (L):	3.048 m
DISPL. (H-Ho):	0.394 m	TIME LAG (To):	165 secs

HYDRAULIC CONDUCTIVITY K= (r*r*ln(L/R))/(2*L*To): 2.1E-04 cm/sec

TIME (actual time)			WATER DEPTH (h)	DISPL. |H - h|	%DISPL. (H-h)/ (H-Ho)
days	(HH:MM:SS) 09:10:00	TOTAL (sec.)			
	09:10:15	15	8.534	0.198	0.503
	09:10:30	30	8.467	0.131	0.333
	09:10:45	45	8.443	0.107	0.272
	09:11:00	60	8.428	0.092	0.234
	09:11:15	75	8.413	0.077	0.196
	09:11:30	90	8.397	0.061	0.155
	09:12:00	120	8.391	0.055	0.140
	09:12:15	135	8.382	0.046	0.117
	09:12:30	150	8.376	0.040	0.102
	09:13:00	180	8.370	0.034	0.086
	09:14:00	240	8.361	0.025	0.064
	09:14:30	270	8.358	0.022	0.056
	09:15:00	300	8.355	0.019	0.048
	09:16:00	360	8.352	0.016	0.041
	09:17:00	420	8.352	0.016	0.041

SINGLE WELL RESPONSE TEST



SINGLE WELL RESPONSE TEST - DATA AND CALCULATIONS
HVORSLEV METHOD (1951)

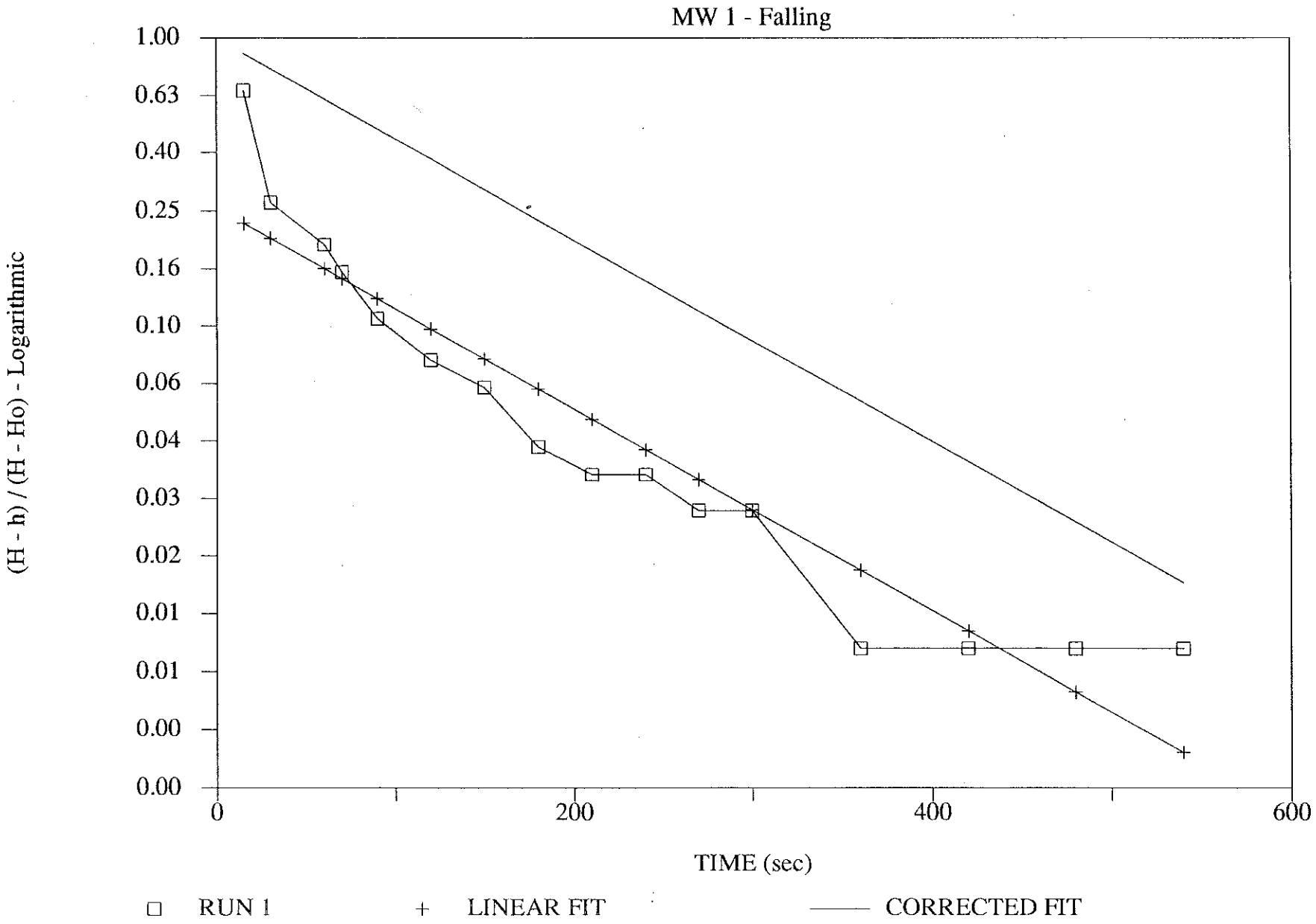
PROJECT NAME:	GOLD SHIELD SOLVENTS	HOLE DESIGNATION:	MW 1
PROJECT NUMBER:	2471	DATE TESTED:	5-12-89
CLIENT:	DETREX - GOLD SHIELD	TEST TYPE:	FALLING
SUPERVISOR:	J. MICHAEL		

REF. ELEVATION:	m AMSL	WELL RADIUS (r):	0.025 m
STATIC DEPTH (H):	8.336 m	BOREHOLE RADIUS (R):	0.100 m
SLUG VOLUME:	0.773 L	SCREEN LENGTH (L):	3.048 m
DISPL. (H-Ho):	0.394 m	TIME LAG (To):	123 secs

HYDRAULIC CONDUCTIVITY K= (r*r*ln(L/R))/(2*L*To): 2.8E-04 cm/sec

TIME (actual time)			WATER	DISPL.	%DISPL.
days	(HH:MM:SS) 09:00:00	TOTAL (sec.)	DEPTH (h)	H - h	(H-h)/ (H-Ho)
	09:00:15	15	8.077	0.259	0.658
	09:00:30	30	8.230	0.106	0.269
	09:01:00	60	8.260	0.076	0.193
	09:01:10	70	8.275	0.061	0.155
	09:01:30	90	8.294	0.042	0.107
	09:02:00	120	8.306	0.030	0.076
	09:02:30	150	8.312	0.024	0.061
	09:03:00	180	8.321	0.015	0.038
	09:03:30	210	8.324	0.012	0.030
	09:04:00	240	8.324	0.012	0.030
	09:04:30	270	8.327	0.009	0.023
	09:05:00	300	8.327	0.009	0.023
	09:06:00	360	8.333	0.003	0.008
	09:07:00	420	8.333	0.003	0.008
	09:08:00	480	8.333	0.003	0.008
	09:09:00	540	8.333	0.003	0.008
	09:10:00	600	8.336	0.000	0.000

SINGLE WELL RESPONSE TEST



APPENDIX E

AVAILABLE WELL RECORDS

GEOLOGICAL SURVEY SAMPLE No.

WATER WELL RECORD

ACT 294 PA 1965

MICHIGAN DEPARTMENT OF PUBLIC HEALTH

1 LOCATION OF WELL

County	Twp.	Fraction	Section No.	Town	Range
Kent	Wyoming	¼ ¼SW ¼	35	6 N/S	12 E/W

Distance And Direction from Road Intersections — OWNER No.

Approx.457'south of R.R. service Road off from Market Ave., to the south.

Street address & City of Well Location Wyoming, Michigan

3 OWNER OF WELL:

Address The Chesapeake & Ohio R.R. C.&O. Building Huntington, West Virginia

2 FORMATION	THICKNESS OF STRATUM	DEPTH TO BOTTOM OF STRATUM
Sand	5	5
Gravel with some boulders	29	34
Sand and gravel	3	37

4 WELL DEPTH: (completed) 37 ft. **Date of Completion** 1-20-67

5 ☒ Cable tool ☐ Rotary ☐ Driven ☐ Dug ☐ Hollow rod ☐ Jetted ☐ Bored ☐ ___

6 USE: ☐ Domestic ☐ Public Supply ☒ Industry ☐ Irrigation ☐ Air Conditioning ☐ Commercial ☐ Test Well ☐ ___

7 CASING: Diam. 4 in. to 32 ft. Depth — Threaded ☒ Welded ☐ — Height: Above/Below surface 1 ft. — Weight 11 lbs/ft. — Drive Shoe? Yes ☒ No ☐

___ in. to ___ ft. Depth

8 SCREEN:

Type: Stainless Dia.: 4

Slot/Gauge 18 Length 5'

Set between 37 ft. and 32 ft.

Fittings: Screwed

9 STATIC WATER LEVEL 15 ft. below land surface

10 PUMPING LEVEL below land surface

___ ft. after ___ hrs. pumping 50 g.p.

___ ft. after ___ hrs. pumping ___ g.p.m.

11 WATER QUALITY in Parts Per Million:

Iron (Fe) ___ Chlorides (Cl) ___

Hardness ___

12 WELL HEAD COMPLETION: ☐ In Approved Pit ☒ Pitless Adapter ☐ 12" Above Grade

13 GROUTING:

Well Grouted? ☐ Yes ☒ No

Material: ☐ Neat Cement ☐ ___

Depth: From ___ ft. to ___ ft.

14 SANITARY:

Nearest Source of possible contamination

75 feet west Direction Septic Tank

Well disinfected upon completion ☒ Yes ☐ No

15 PUMP:

Manufacturer's Name Deming

Model Number 2XLF¾ HP 1/3

Length of Drop Pipe 26 ft. capacity 7 G.P.M.

Type: ☒ Submersible ☐ ___ ☐ Jet ☐ Reciprocating

16 Remarks, elevation, source of data, etc.

ADDED INFO. BY DRILLER. ITEM NO.

*CORRECTED BY:

**ADDITION BY:

17 WATER WELL CONTRACTOR'S CERTIFICATION:

This well was drilled under my jurisdiction and this report is true to the best of my knowledge and belief.

C.S. Raymer Company (REGISTERED BUSINESS NAME) 0384 (REGISTRATION NO.)

Address 1125 Covell Rd., N.W.

Signed ___ (AUTHORIZED REPRESENTATIVE) Date 2-17-67

D67D 100M 6-66 APR 7 1967

GEOLOGICAL SURVEY COPY

GEOLOGICAL SURVEY SAMPLE No. [ ]

WATER WELL RECORD

ACT 294 PA 1965

MICHIGAN DEPARTMENT OF PUBLIC HEALTH

1 LOCATION OF WELL

County	Twp.	Fraction	Section No.	Town	Range
Kent	Wyoming	¼ ¼ SW¼	35	7 (N/S.)	12 (E/W.)

Distance And Direction from Road Intersections: Approx 450' south of R.R. service Road off from Market Ave to the south

OWNER No. 2

Street address & City of Well Location: Wyoming yards, Grand Rapids

3 OWNER OF WELL:

Address: The Chesapeake & Ohio R.R. C.& O. Building Huntington, West Virginia

2 FORMATION	THICKNESS OF STRATUM	DEPTH TO BOTTOM OF STRATUM
Medium sand	11	11
Sand & Gravel	8	19
Red Clay	9	28
Coarse gravel	2	30
Medium sand	20	50

R.R yard is between Indian Mound Dr. & Chicago Dr.

4 WELL DEPTH: (completed) 50 ft. Date of Completion 10-4-66

5 ☒ Cable tool ☐ Rotary ☐ Driven ☐ Dug ☐ Hollow rod ☐ Jetted ☐ Bored ☐ ___

6 USE: ☐ Domestic ☐ Public Supply ☒ Industry ☐ Irrigation ☐ Air Conditioning ☐ Commercial ☐ Test Well ☐ ___

7 CASING: Diam. 8 in. to 35 ft. Depth; Threaded ☐ Welded ☒; Height: Above/Below surface 1 ft.; Weight 29 lbs/ft.; ___ in. to ___ ft. Depth; Drive Shoe? Yes ☒ No ☐

8 SCREEN:

Type: Johnson Dia.: 8"

Slot/Gauze 15slot Length 15

Set between 35 ft. and 50 ft.

Fittings: Standard

9 STATIC WATER LEVEL

11 ft. below land surface

10 PUMPING LEVEL below land surface

12 ft. after 5 hrs. pumping 100 g.p.m.

12¼ ft. after 8 hrs. pumping 100 g.p.m.

11 WATER QUALITY in Parts Per Million:

Iron (Fe) ___ Chlorides (Cl) ___

Hardness ___

12 WELL HEAD COMPLETION: ☐ In Approved Pit ☐ Pitless Adapter ☒ 12" Above Grade

13 GROUTING:

Well Grouted? ☐ Yes ☒ No

Material: ☐ Neat Cement ☐ ___

Depth: From ___ ft. to ___ ft.

14 SANITARY:

Nearest Source of possible contamination

200 feet South rection Septic tank

Well disinfected upon completion ☐ Yes ☐ No

15 PUMP:

Manufacturer's Name Deming

Model Number 4700 HP 3

Length of Drop Pipe 20 ft. capacity 150 G.P.M.

Type: ☐ Submersible ☐ Deep Well Turbine ☐ Jet ☐ Reciprocating

16 Remarks, elevation, source of data, etc.

ADDED INFO. BY DRILLER, ITEM NO. /

*CORRECTED BY:

**ADDITION BY:

17 WATER WELL CONTRACTOR'S CERTIFICATION:

This well was drilled under my jurisdiction and this report is true to the best of my knowledge and belief.

C.S. Raymer Company (REGISTERED BUSINESS NAME) 0384 (REGISTRATION NO.)

Address 1125 Covell Rd., N.W. Grand Rapids

Signed ___ (AUTHORIZED REPRESENTATIVE) Date 11-29-66

D67D 100M 6-66

JAN - 3 1967 GEOLOGICAL SURVEY COPY

GEOLOGICAL SURVEY SAMPLE No. [ ]

WATER WELL RECORD

ACT 294 PA 1965

MICHIGAN DEPARTMENT OF PUBLIC HEALTH

1 LOCATION OF WELL

County	Twp.	Fraction	Section No.	Town	Range
Kent	Wyoming	¼ ¼ SW ¼	35	7 (N/S.)	12 E/(W)

Distance And Direction from Road Intersections: Approx 450 south of R.R. Service Road off from market Ave to the south

OWNER No. 1

Street address & City of Well Location: Wyoming Yards, Grand Rapids,

3 OWNER OF WELL: The Chesapeake & Ohio R.R.

Address C.& O. Building Huntington, West Virginia

2 FORMATION	THICKNESS OF STRATUM	DEPTH TO BOTTOM OF STRATUM
Fine Sand	10	10
Fine sand and some gravel	9	19
Medium sand and gravel	31	50
Railway yards are inbetween Indian Mounds Dr. & Chicago Dr.		

4 WELL DEPTH: (completed) 50 ft. Date of Completion 9-30-66

5 [x] Cable tool [ ] Rotary [ ] Driven [ ] Dug [ ] Hollow rod [ ] Jetted [ ] Bored [ ] ___

6 USE: [ ] Domestic [ ] Public Supply [x] Industry [ ] Irrigation [ ] Air Conditioning [ ] Commercial [ ] Test Well [ ] ___

7 CASING: Diam. 8 in. to 35 ft. Depth; Threaded [ ] Welded [x]; Height: Above/~~Below~~ surface 1 ft.; Weight 29 lbs/ft.; ___ in. to ___ ft. Depth; Drive Shoe? Yes [x] No [ ]

8 SCREEN: Type: Johnson Dia.: 8"

Slot/~~Gauge~~ top 10' 15 Length 15'

Set between Bottom 5' 30 35 ft. and 50 ft.

Fittings: Screwed

9 STATIC WATER LEVEL 11 ft. below land surface

10 PUMPING LEVEL below land surface

12 ft. after 5 hrs. pumping 100 g.p

12'6" ft. after 8 hrs. pumping 100 g.p.m.

11 WATER QUALITY in Parts Per Million:

Iron (Fe) ___ Chlorides (Cl) ___

Hardness ___

12 WELL HEAD COMPLETION: [ ] In Approved Pit [ ] Pitless Adapter [x] 12" Above Grade

13 GROUTING:

Well Grouted? [ ] Yes [x] No

Material: [ ] Neat Cement [ ] ___

Depth: From ___ ft. to ___ ft.

14 SANITARY:

Nearest Source of possible contamination

Approx 500 feet West direction Septic tank

Well disinfected upon completion [ ] Yes [ ] No

15 PUMP:

Manufacturer's Name Deming

Model Number 4700 HP 3

Length of Drop Pipe 20 ft. capacity 150 G.P.M.

Type: [ ] Submersible [ ] Deep Well Turbine [ ] Jet [ ] Reciprocating

16 Remarks, elevation, source of data, etc.

ADDED INFO. BY DRILLER, ITEM NO. /

CORRECTED BY:

ADDITION

17 WATER WELL CONTRACTOR'S CERTIFICATION:

This well was drilled under my jurisdiction and this report is true to the best of my knowledge and belief.

C.S. Raymer Company — REGISTERED BUSINESS NAME — 0384 — REGISTRATION NO.

Address 1125 Covell Rd., N.W. Grand Rapids,

Signed [signature] — AUTHORIZED REPRESENTATIVE — Date 11-29-66

067D 100M 6-66

GEOLOGICAL SURVEY COPY

GEOLOGICAL SURVEY SAMPLE No.

WATER WELL RECORD

ACT 294 PA 1965

MICHIGAN DEPARTMENT OF PUBLIC HEALTH

1 LOCATION OF WELL

County	Twp.	Fraction	Section No.	Town	Range
Kent	Wyoming	¼ ¼ SW ¼	35	5 N	12 E/W

Distance And Direction from Road Intersections — OWNER No.

Approx 545' south of R.R. Service Road off from Market Ave.S.W., to the south

Street address & City of Well Location: Wyoming, Michigan

3 OWNER OF WELL:

The Chesapeake & Ohio R.R.

Address C.& O. Building, Huntington, West Virginia

2 FORMATION	THICKNESS OF STRATUM	DEPTH TO BOTTOM OF STRATUM
Sand	8	8
Gravel & clay Some sand	17	25
Clean sand	25	50

4 WELL DEPTH: (completed) 50 ft. Date of Completion 1-26-67

5 ☒ Cable tool ☐ Rotary ☐ Driven ☐ Dug ☐ Hollow rod ☐ Jetted ☐ Bored ☐ ___

6 USE: ☐ Domestic ☐ Public Supply ☒ Industry ☐ Irrigation ☐ Air Conditioning ☐ Commercial ☐ Test Well ☐ ___

7 CASING: Threaded ☒ Welded ☐

Diam. 4 in. to 45 ft. Depth

___ in. to ___ ft. Depth

Height: Above/Below surface 1 ft.

Weight 11 lbs/ft.

Drive Shoe? Yes ☒ No ☐

8 SCREEN:

Type: Stainless Dia.: 4"

Slot/~~Gauge~~ 7 Length 5'

Set between 45 ft. and 50 ft.

Fittings: Screwed

9 STATIC WATER LEVEL

10 ft. below land surface

10 PUMPING LEVEL below land surface

___ ft. after ___ hrs. pumping 100 g.p.m.

___ ft. after ___ hrs. pumping ___ g.p.m.

11 WATER QUALITY in Parts Per Million:

Iron (Fe) ___ Chlorides (Cl) ___

Hardness ___

12 WELL HEAD COMPLETION: ☐ In Approved Pit ☒ Pitless Adapter ☐ 12" Above Grade

13 GROUTING:

Well Grouted? ☐ Yes ☒ No

Material: ☐ Neat Cement ☐ ___

Depth: From ___ ft. to ___ ft.

14 SANITARY:

Nearest Source of possible contamination

50 feet South direction ~~Septic tank~~

Well disinfected upon completion ☒ Yes ☐ No

15 PUMP:

Manufacturer's Name Deming

Model Number 2XLF4 HP 1/3

Length of Drop Pipe 26 ft. capacity 7 G.P.M.

Type: ☒ Submersible ☐ ___ ☐ Jet ☐ Reciprocating

16 Remarks, elevation, source of data, etc.

ADDED INFO. BY DRILLER, ITEM NO.

*CORRECTED BY:

**ADDITION BY:

17 WATER WELL CONTRACTOR'S CERTIFICATION:

This well was drilled under my jurisdiction and this report is true to the best of my knowledge and belief.

C.S. Raymer Company — REGISTERED BUSINESS NAME

0384 — REGISTRATION NO.

Address 1125 Covell Rd., N.W. Grand Rapids

Signed ___ — AUTHORIZED REPRESENTATIVE

Date 2-17-67

D67D 100M 6-66 APR 7 1967

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GEOLOGICAL SURVEY SAMPLE No. DEC 10 1982

WATER WELL RECORD

ACT 294 PA 1965

MICHIGAN DEPARTMENT OF PUBLIC HEALTH

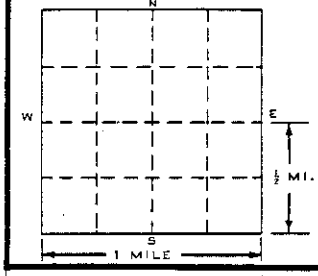
1 LOCATION OF WELL

County	Township Name	Fraction	Section Number	Town Number	Range Number
Kent	Grand Rapids	¼ ¼ ¼	31	N/S.	E/W.

Distance And Direction from Road Intersections
40 ft. W. of Saratoga
& M.I. S. of Ada Dr.
Street Address of Well Location 833 Saratoga S. E.

Locate with "X" in section below

Sketch Map:



3 OWNER OF WELL:
Deck Cooley
Address 505 Lovett S. E.
E. Grand Rapids, MI 49506

4 WELL DEPTH: (completed) 41 ft. Date of Completion 9-30-82

5 ☒ Cable tool ☐ Rotary ☐ Driven ☐ Dug ☐ Hollow rod ☐ Jetted ☐ Bored ☐ ____

6 USE: ☒ Domestic ☐ Public Supply ☐ Industry ☐ Irrigation ☐ Air Conditioning ☐ Commercial ☐ Test Well ☐ ____

7 CASING: Threaded ☒ Welded ☐ Diam. 4 in. to 36 ft. Depth; ____ in. to ____ ft. Depth
Height: Above/Below Surface 1/ ft. Weight 11 lbs./ft. Drive Shoe? Yes ☒ No ☐

2 FORMATION	THICKNESS OF STRATUM	DEPTH TO BOTTOM OF STRATUM
Sand	3	3
Brown clay	1	4
Black sand	10	14
Wet sand	9	23
Grey clay	8	31
Water sand	10	41

8 SCREEN:
Type: Slotted Dia.: 4"
Slot/Gauze 7/80 Length 5'
Set between 36 ft. and 41 ft.
Fittings: Lead packer

9 STATIC WATER LEVEL
0 ft. below land surface

10 PUMPING LEVEL below land surface
____ ft. after 1½ hrs. pumping 40 g.p.m.
____ ft. after ____ hrs. pumping ____ g.p.m.

11 WATER QUALITY in Parts Per Million:
Iron (Fe) ____ Chlorides (Cl) ____
Hardness ____ Other ____

12 WELL HEAD COMPLETION: ☐ In Approved Pit ☒ Pitless Adapter ☐ 12" Above Grade

13 Well Grouted? ☐ Yes ☒ No
☐ Neat Cement ☐ Bentonite ☐ ____
Depth: From ____ ft. to ____ ft.

14 Nearest Source of possible contamination
____ feet NONE Direction ____ Type
Well disinfected upon completion ☒ Yes ☐ No

15 PUMP ☐ Not installed
Manufacturer's Name Burks
Model Number 5SN8B HP ½ Volts 230
Length of Drop Pipe 20 ft. capacity 560 G.P.M.
Type: ☒ Submersible 30 psi ☐ Jet ☐ Reciprocating
WX 202 288828

RECEIVED
Mich. Dept. of Public Health
NOV 29 1982
Occupational Health
Services Administration

RECEIVED
OCT - 4
KENT COUNTY

USE A 2ND SHEET IF NEEDED

16 Remarks, elevation, source of data, etc.
ADDED INFO BY DRILLER, ITEM NO.
*CORRECTED BY
**ADDITION BY
ELEVATION
DEPTH TO ROCK

17 WATER WELL CONTRACTOR'S CERTIFICATION:
This well was drilled under my jurisdiction and this report is true to the best of my knowledge and belief.
Stovall Well Drilling Co 41-0761
REGISTERED BUSINESS NAME REGISTRATION NO.
Address 2132 Four Mile Rd. N.W.
Signed Howard Stovall Date 10/4/82
AUTHORIZED REPRESENTATIVE

D67d 100M (Rev. 12-68)

GEOLOGICAL SURVEY COPY

10/4/82

Cons.7401 Rev.12/63

Page of

Sample No.

MICHIGAN DEPARTMENT OF CONSERVATION
GEOLOGICAL SURVEY DIVISION

WATER WELL RECORD

Permit No.

Owner No.

County	Twp.		Sec.	Town	Range
Kent	Grand Rapids	NW ¼ SW ¼ NW ¼	30	7N N/S.	11W E/W.

Distance from Roads, Section Lines, etc.

FORMATION	THICKNESS OF STRATUM	DEPTH TO BOTTOM OF STRATUM

Owner: Lawrence Engberth

Address: 4652 Division Ave SE Gr. Rapids

Driller and Address: Don Yerrick, Gr. Rapids

Well Depth: 18 ft. Date of Completion

☐ Cable tool ☐ Rotary ☐ Dug ☐ R.C.
☐ Driven ☐ Jetted ☐ Bored

Use: ☐ Domestic ☐ Public Supply ☐ Industry
☒ Irrigation ☐ Air Conditioning ☐ Dewatering
☐ Test Well ☐ _____

Casing: Diam. 2 in. to _____ ft. Depth
_____ in. to _____ ft. Depth

Height: Above/Below surface _____ ft.
Type-Weight

Screen:
Type: _____ Dia: _____
Slot/Gauze _____ Length _____
Set between _____ ft. and _____ ft.
Accessories:

Water level:
_____ ft. above/below _____
_____ ft. above/below _____
Meas. by Date

Drawdown:
_____ ft. after ____ hrs. pumping ____ g.p.m.
_____ ft. after ____ hrs. pumping ____ g.p.m.
Meas. by Date

Flow:
g.p.m./g.p.h. Temp: °F

Water Quality in Parts Per Million:
Iron (Fe) _____ Chlorides (Cl) _____
Hardness _____

Elevation:
ft. above

Source of data: USGS

Record by: Bissell Date: 1/11/65

Remarks:

GEOLOGICAL SURVEY SAMPLE No.

SEP 19 1979

WATER WELL RECORD

ACT 294 PA 1965

MICHIGAN DEPARTMENT OF PUBLIC HEALTH

1 LOCATION OF WELL

County	Township Name	Fraction	Section Number	Town Number	Range Number
Kent	N.E. Grand Rapids	SE¼ SE¼ SW¼	31	7 N	11 W

Distance And Direction from Road Intersections: On Hull St ½ mile East of Division St.

Street address & City of Well Location

Locate with "X" in section below — Sketch Map: (N, W, E, S; ½ MI.; 1 MILE)

3 OWNER OF WELL:

Gary Rider

Address: 650 E Hull, Sparta Michigan

4 WELL DEPTH: (completed) Date of Completion

70 ft. — 4/16/79

5

☒ Cable tool ☐ Rotary ☐ Driven ☐ Dug
☐ Hollow rod ☐ Jetted ☐ Bored ☐ ____

6 USE:

☒ Domestic ☐ Public Supply ☐ Industry
☐ Irrigation ☐ Air Conditioning ☐ Commercial
☐ Test Well ☐ ____

7 CASING:

Threaded ☐ Welded ☐

4 in. to 65 ft. Depth

____ in. to ____ ft. Depth

Height: Above/Below Surface ____ ft.

Weight ____ lbs./ft.

Drive Shoe? Yes ☐ No ☐

2 FORMATION

FORMATION	THICKNESS OF STRATUM	DEPTH TO BOTTOM OF STRATUM
Sand	48	48
Clay	2	50
Sand Gravel	20	70

8 SCREEN:

Type: Stainless Dia.: 3

Slot/Gauze 60 Length 5 ft

Set between 65 ft. and 70 ft.

Fittings: K Packer 12' mills

9 STATIC WATER LEVEL

50 ft. below land surface

10 PUMPING LEVEL below land surface

50 ft. after 1 hrs. pumping 20 g.p.m.

____ ft. after ____ hrs. pumping ____ g.p.m.

11 WATER QUALITY in Parts Per Million:

Iron (Fe) ____ Chlorides (Cl) ____

Hardness ____ Other ____

12 WELL HEAD COMPLETION:

☐ In Approved Pit
☒ Pitless Adapter ☐ 12" Above Grade

13 Well Grouted? ☐ Yes ☐ No

☐ Neat Cement ☐ Bentonite ☐ ____

Depth: From ____ ft. to ____ ft.

14 Nearest Source of possible contamination

____ feet ____ Direction ____ Type

Well disinfected upon completion ☐ Yes ☐ No

15 PUMP:

☐ Not installed

Manufacturer's Name Byron

Model Number SC 72-04 HP ¾ Volts 220

Length of Drop Pipe 42 ft. capacity 20 G.P.M.

Type: ☒ Submersible ☐ Jet ☐ Reciprocating

ADDED INFO BY DRILLER, ITEM NO.
*CORRECTED BY SP
**ADDITION BY
ELEVATION
DEPTH TO ROCK

USE A 2ND SHEET IF NEEDED

16 Remarks: Elevation, source of data, etc.

RECEIVED
AUG 24 1979
KENT COUNTY HEALTH DEPT.

17 WATER WELL CONTRACTOR'S CERTIFICATION:

This well was drilled under my jurisdiction and this report is true to the best of my knowledge and belief.

Overgaard Pedden — REGISTERED BUSINESS NAME — 0445 — REGISTRATION NO.

Address: Hudsonville Mich RH 1

Signed: James Overgaard — AUTHORIZED REPRESENTATIVE — Date 4/20/79

D67d 100M (Rev. 12-68)

GEOLOGICAL SURVEY COPY

GEOLOGICAL SURVEY NO.

MICHIGAN DEPARTMENT OF PUBLIC HEALTH

WATER WELL AND PUMP RECORD

PERMIT NUMBER

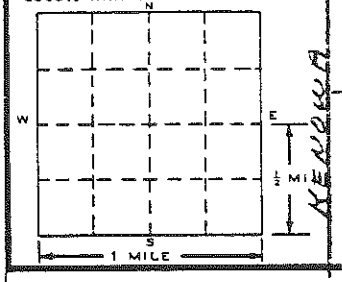
1 LOCATION OF WELL

County	Township Name	Fraction	Section Number	Town Number	Range Number
Kent	City of Walker	¼ ¼ ¼	31	7 N/S	12 E/W

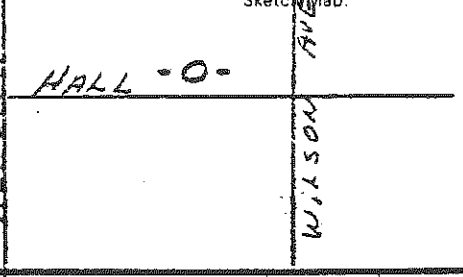
Distance And Direction From Road Intersection: 30' North of Hall Street-East of Kenowa Ave.

Street Address & City of Well Location: 4545 Hall St., Grand Rapids

Locate with "X" in Section Below



Sketch Map:



3 OWNER OF WELL: Mr. Fred Huizinga

Address: 4545 Hall Street, S.W., Grand Rapids, MI.

Address Same As Well Location? ☒ Yes ☐ No

4 WELL DEPTH: 60 FT. | Date Completed: MO. 6 DAY 2 YEAR 86 | ☒ New Well ☐ Replacement Well

5 ☐ Cable tool ☒ Rotary ☐ Driven ☐ Dug ☐ Hollow rod ☐ Auger ☐ Jetted ☐ _____

6 USE: ☒ Domestic ☐ Type I Public ☐ Type II Public ☐ Irrigation ☐ Type IIa Public ☐ Heat pump ☐ Test Well ☐ Type IIb Public ☐ _____

7 CASING: Diameter ☐ Steel ☐ Threaded ☒ Plastic ☐ Welded

5 in. to 55 ft. depth

_____ in. to _____ ft. depth

Grouted Drill Hole Diameter

_____ in. to _____ ft. depth

_____ in. to _____ ft. depth

Height: Above/Below Surface 1 ft.

Weight 2.8 lbs./ft.

Drive Shoe ☐ Yes ☒ No

2 FORMATION DESCRIPTION	THICKNESS OF STRATUM	DEPTH TO BOTTOM OF STRATUM
Sand	15	15
Brown Clay	2	17
Gray Clay	3	20
Sand	3	23
Gray Clay	27	50
Sand T.D.*	10	60*
Gray Clay	2	62

8 SCREEN: ☐ Not Installed

Type Stainless St. Diameter 4"

Slot/Gauge 10 Length 5'

Set between 55 ft. and 60 ft.

FITTINGS: ☐ K-Packer ☐ Lead Packer ☐ Bremer Check ☐ Blank above screen _____ ft. Other Screwed

9 STATIC WATER LEVEL: 16 ft. below land surface ☐ Flow

10 PUMPING LEVEL: below land surface

_____ ft. after 4 hrs. pumping at 35 G.P.M.

_____ ft. after _____ hrs. pumping at _____ G.P.M.

11 WELL HEAD COMPLETION: ☒ Pitless adapter ☐ 12" above grade ☐ Basement offset ☐ Approved pit

12 WELL GROUTED? ☐ No ☒ Yes From 0 to 55 ft.

☐ Neat cement ☒ Bentonite ☐ Other _____

No. of bags of cement _____ Additives _____

13 Nearest source of possible contamination

Type Septic Tank Distance 150 ft. Direction North

Well disinfected upon completion? ☒ Yes ☐ No

Was old well plugged? ☐ Yes ☐ No

14 PUMP: ☐ Not Installed ☐ Pump Installation Only

Manufacturer's name Aermotor

Model number A12-75 HP 3/4 Volts 230

Length of Drop Pipe 45 ft. capacity 15 G.P.M.

TYPE: ☒ Submersible ☐ Jet _____

PRESSURE TANK:

Manufacturer's name Used Owners

Model number _____ Capacity _____ Gallons

USE A 2ND SHEET IF NEEDED

RECEIVED
Mich. Dept. of Public Health
OCT 28 1986
Bureau of Environmental and Occupational Health

15. Remarks, elevation, source of data, etc.

16. WATER WELL CONTRACTOR'S CERTIFICATION: This well was drilled under my jurisdiction and this report is true to the best of my knowledge and belief.

Raymer Company, Inc. 0384

REGISTERED BUSINESS NAME REGISTRATION NO.

Address 3311 3 Mile Rd. N.W. Grand Rapids, MI.

Signed G. F. Raymer Jr. Date July 10, 1986

AUTHORIZED REPRESENTATIVE

17. Rig Operator's Name:

D67d 12/85

Authority: Act 368 PA 1978
Completion: Required
Penalty: Conviction of a violation of any provision is a misdemeanor.

GEOLOGICAL SURVEY COPY

Grand Rapids Artesian Well

Location: SE ¼ NW ¼ NW ¼ Section 36, T. 7N., R. 12W.

Elevation: About 638 (?) feet above sea level.

Record By: C. E. Wright. Drilled in 1908.

	Thickness (Feet)	Depth (Feet)
PLEISTOCENE:	10	10
MISSISSIPPIAN:		
Michigan Formation:		
Black clay slate	47	57
Plaster rock (gypsum) mixed with clay slate	71	128
Napoleon Formation (Upper Marshall):		
Sandstone, dark and light colored	17	145
Sandstone, light gray. Fresh water, increases with depth	95	240
Lower Marshall Formation:		
Hard black coarse sandstone. Increase of fresh water	19	259
Blue clay slate	12	271
Ashcolored sandstone, mixed with clay seams and layers of soapstone; fine textured. Small qusnity of weak brine, 20°	129	400
Coldwater formation:		
Sandy shale at top and clay-rock boulders and sheets below	20	420
Light blue to ash-colored shale, with very little change in color except for short places which are little darker. Quire uniform as to hardness. Except these (?) the lower 250 feet has more hard streaks and boulders that would make slate pencils	735	1155
Dark hard water-lime from 702 to 712 feet. There is a streak of ten feet from 712 to 722 feet of calcareous water-lime, dark and hard at top and softer below; but it is all hard rock		
Dark red clay, soft	20	1175
Berea Formation:		
Sandstone, brine 26°, small amount	30	1205
MISSISSIPPIAN :		
Bedford Formation:		
Light to greenish blue shale, mixed with clay rock. Streaks and boulders of gas-scented material	295	1500
DEVONIAN:		
Antrim Formation:		
Black slate rock, scent of gas at top and stronger in depth and very strong at bottom	208	1708
Black slate or hard rock, strong odor of gas & oil	67	1775
Traverse Formation		
Drab limestone. Changes color nearly every foot	52	1827
Drab magnesian limestone	28	1855
Very dark water lime	10	1865
Each screw changes color	20	1885
Limestone; light gray & medium hard in upper portion and dark drab and hard below	315	2200
Gas marl, limestone and brine	20	2220

Walker (Kent County)

James E. Flanigan

J. B. Martin #1 Permit #7015

Drilling Contractor: Company tools

Location: NW¼ of SW¼ of NW¼ of section 35, T. 7 N., R. 12 W.
945.2 feet from south and 330 feet from west line of quarter section.

Elevation: 596.9 feet above sea level.

Record by: L. C. Wickersham from driller's log.	Thickness (Feet)	Depth (Feet)
PLEISTOCENE:		
Drift:		
No record	100	100
MISSISSIPPIAN:		
Marshall (Undivided):		
Marshall, white, soft	110	210
Slate, gray, soft	20	230
Sand, white, soft	52	282
Shale, gray, soft	5	287
Sand, white, soft	86	373
Coldwater:		
Slate, gray, soft	30	403
Shell, hard	8	411
Slate, gray, muddy	689	1100
Redrock	19	1119
Ellsworth:		
Berea - hard and sharp (Berea horizon ?)	23	1142
Shale, gray	458	1600
MISSISSIPPIAN-DEVONIAN:		
Antrim:		
Shale, brown	116	1716
DEVONIAN:		
Traverse:		
Traverse shale	65	1781
Traverse lime	149	1930

Casing record:
10" 37'
8¼" 112'
6-5/8" 417'
Reduced hole 1781'

TOTAL DEPTH 1930

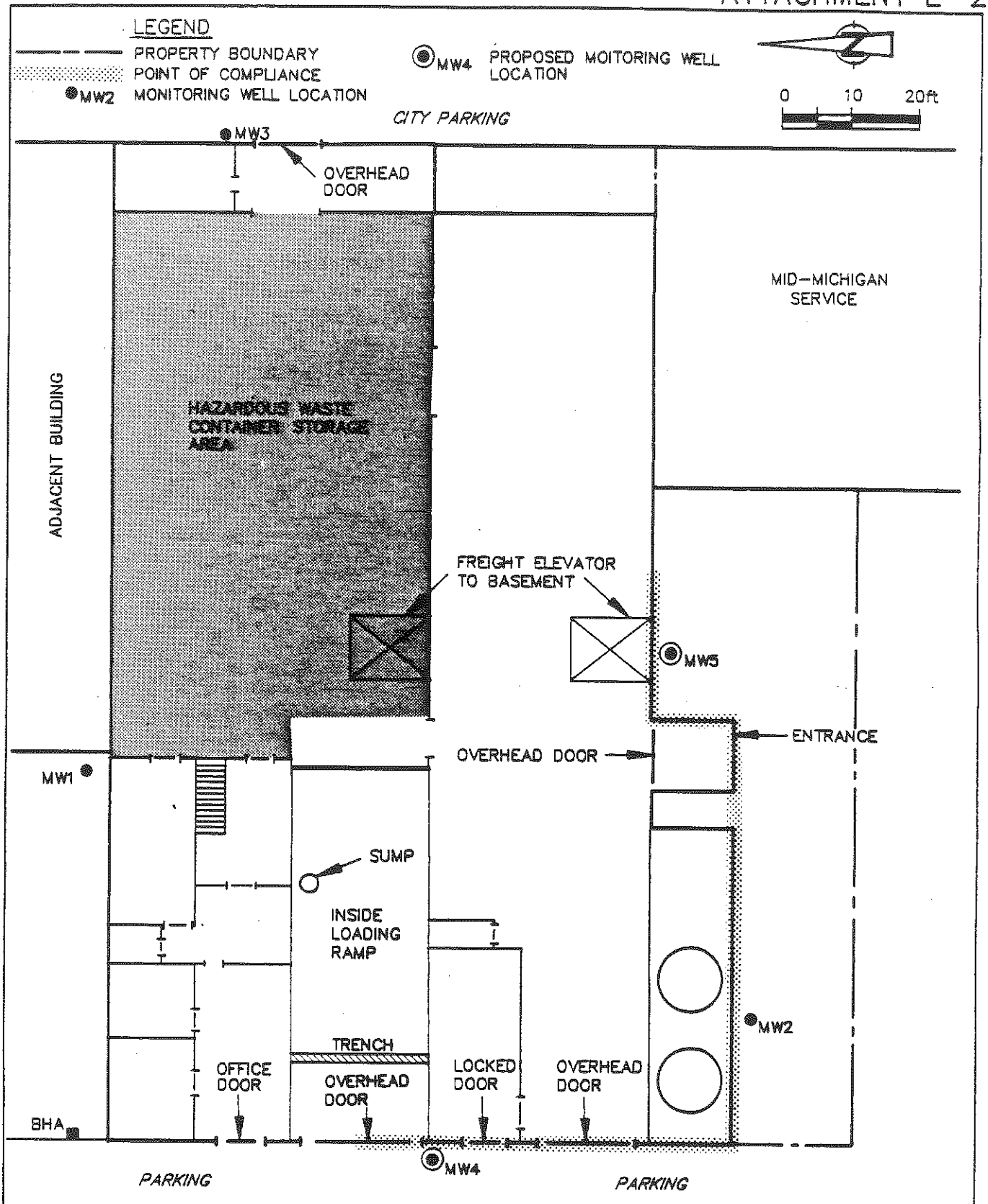
Commenced: 11-14-39
Completed: 12-6-39
Initial production: Dry hole.

ATTACHMENT E2

Date: 06/19/89
Revision: 89-1
Attachment: E-2

ATTACHMENT E-2

PROPOSED MONITORING WELL LOCATIONS



PROPOSED MONITORING WELL LOCATIONS

Detrex Corporation

Gold Shield Solvents, Grand Rapids

CRA

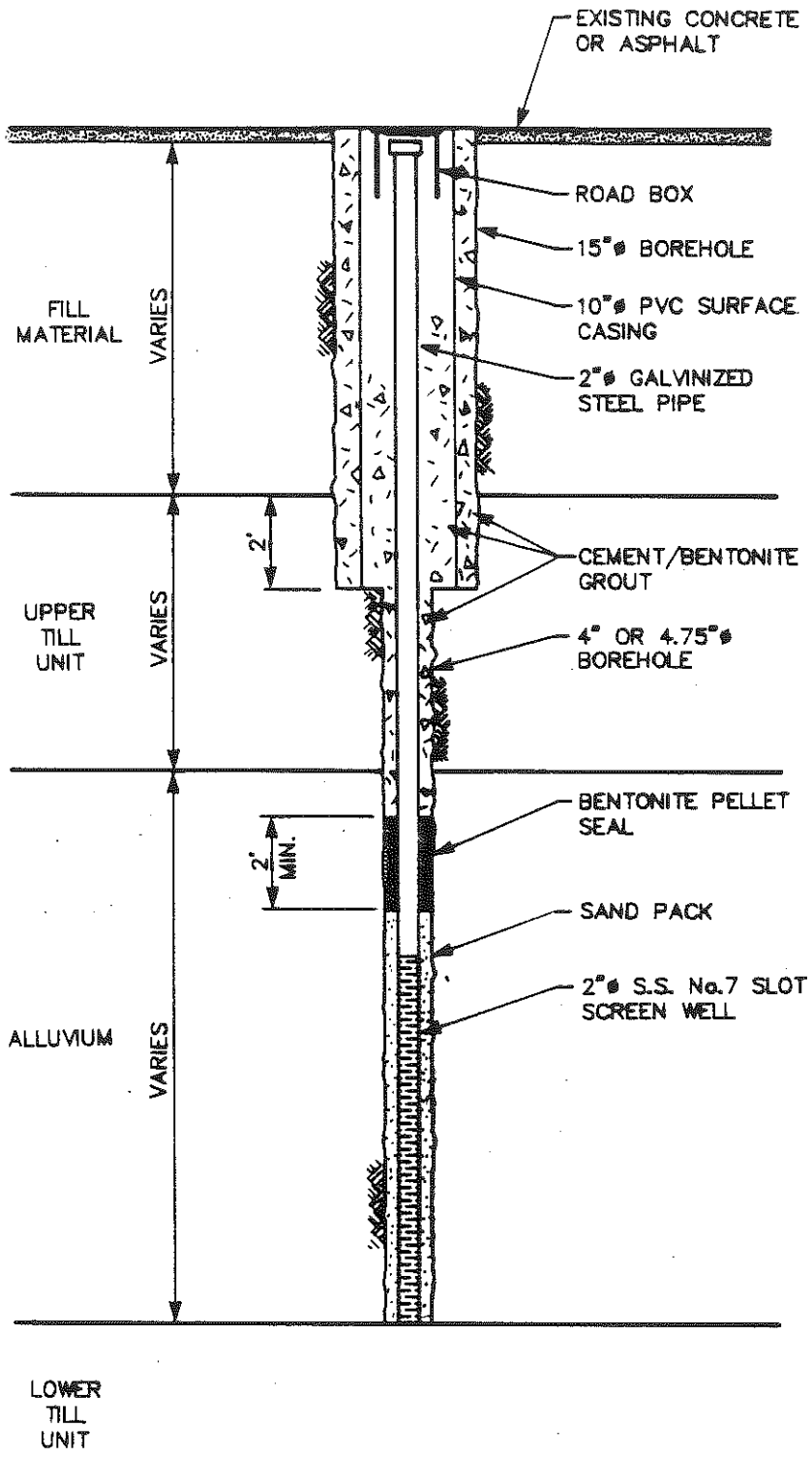
2471-4/11/88-6-D-1

ATTACHMENT E3

Date: 06/19/89
Revision: 89-1
Attachment: E-3

ATTACHMENT E-3

TYPICAL MONITORING WELL DETAIL



TYPICAL MONITORING WELL DETAIL
Detrex Corporation
Gold Shield Solvents, Grand Rapids

CRA

2471-19/06/89-6-D-0

ATTACHMENT E4

ATTACHMENT E-4

SAMPLING AND ANALYSIS PLAN

DETREX CORPORATION

GOLD SHIELD SOLVENTS

GENERAL RAPIDS, MICHIGAN

TABLE OF CONTENTS

LIST OF TABLES

LIST OF APPENDICES

1.0 INTRODUCTION

The Sampling and Analysis Plan presented in this report describes the procedures for the collection of groundwater samples from the detection monitoring system at the Gold Shield Solvents facility in Grand Rapids, Michigan.

This plan will be kept on site for use of the sampling personnel.

2.0 HYDRAULIC RESPONSE TESTING

Subsequent to well development the proposed and existing uppermost aquifer wells will be subjected to single well response tests, to determine the in situ horizontal hydraulic conductivity of the screened materials.

One of the following three methods will be utilized to perform the single well response test at each well:

1. Falling and Rising Head Test - Slug Method

   A precleaned slug, of known volume will be introduced into the well with subsequent monitoring of the water level with time (falling head test). After the well stabilizes, the slug will be removed causing the water level to drop instantaneously. The rising water level will be subsequently monitored until the well stabilizes (rising head test).

2. Falling Head Test - Injection Method

   A known volume of water from an approved source will be instantaneously injected into the well. The recovery of the water level within the well will be monitored with time until the well stabilizes.

3. Constant Head Test - Injection Method

   Water from an approved source will be injected into the well until the desired water level elevation is reached at which time the water supply will be governed to maintain that elevation. A constant injection rate will be maintained.

Field personnel will select the appropriate response test to be performed. The preferred response test to be conducted will be test 1, followed in order by test 2, then test 3.

3.0 GROUNDWATER SAMPLING

All detection system monitoring wells will be sampled according to the following protocols.

1. New disposable latex gloves will be used when sampling each well. Additional gloves changes will be made for each sampling.

2. The sampler shall measure and record the depth to water in each well to the nearest 0.01 foot using an electric tape. The electric tape will be decontaminated prior to use in each well.

3. Prior to sampling, each well will be prebailed using a dedicated stainless steel bottom filling bailer to remove a minimum of three times the standing water volume in the well or until dry. In the event that a well is bailed dry prior to achieving three well volumes, groundwater will be permitted to recover to a level sufficient for sample collection. Upon recovery, one final bailer volume will then be used for sample collection. Prior to use in the initial sampling event, the bailer will be precleaned with a isopropanol, distilled water, isopropanol and distilled water rinse sequence and allowed to air dry. Purged groundwater not used for sampling will be collected and contained for proper disposal.

4. After the required standing well water has been purged, water samples will be collected using a dedicated stainless steel bottom filling bailer. The bailer will be fitted with a 5-foot stainless steel cable attached to a nylon rope. During sampling the nylon report will not contact the water. New nylon rope will be used for each monitoring well.

5. Following collection, the samples shall be preserved by the field sampling personnel appropriately as noted in Table 1; and then stored/shipped in a refrigerated unit at a temperature of approximately 4°C (40°F).

6. Samples will be collected from each well for the field analyses of pH, and specific conductance. Calibration of the field instruments will be undertaken prior to each sampling round.

7. All disposable gloves, rinsings and nylon ropes will be collected and contained on site for proper disposal.

8. A Field Blank and Field Duplicate sample will be collected at a frequency of one per sample round and submitted for the same analysis as the groundwater samples.

TABLE 1

SAMPLE COLLECTION,
PRESERVATION AND SHIPPING PROTOCOL SUMMARY

Bottle No.	*Bottle Size*	*Preservation*	*Shipping*	*Parameters*
1 and 2	40 mL glass septum vial	Cool 4°C	Overnight Courier	1,1,1-Trichloroethane Trichloroethylene Methylene Chloride Tetrachloroethylene Trichlorotrifluoroethane

4.0 SAMPLE LABELING AND CONTROL

Sample labeling and control will be consistent with the procedures discussed below.

4.1 INITIAL LABELING OF SAMPLES

A unique sample numbering system will be used to identify each collected sample. This system will provide a tracking number to allow retrieval and cross-referencing of sample information. A listing of the sample identification numbers with written descriptions of sample location, type, and date will be maintained by the sampling personnel. The sample number system to be used is described as follows:

Example:	W	-	061989 - AA-XXXX
where:	W	-	Designates sample type (W - WATER)
	061989	-	date
	AA	-	sampler initials
	XXXX	-	sequential number starting with 0001

QC samples will also be numbered with a unique location number.

Sampling personnel will be responsible for recording the sampling activities for each day and will record in a log book the following with respect to each sample:

- Unique sample identification number
- Sampling location identification
- Date/time of sample collection
- Sampling data/remarks

4.2 CHAIN-OF-CUSTODY

Chain-of-custody records will be used to track all samples from the time of sampling to the arrival of samples at the laboratory. Three original copies of the chain-of-custody record will accompany the sample shipment to the laboratory and will be signed and retained by the receiving laboratory's sample custodian. A copy of the chain-of-custody record will be retained by the shipper. Two completed copies will be returned to Detrex or

their representative by the laboratory. A typical chain-of-custody form is presented in Appendix A.

4.3 LABORATORY CUSTODY PROCEDURES

The laboratory will designate a "sample custodian" and an alternate to act in his absence. In addition, the laboratory will set aside as a "sample storage security area" an isolated room which should be secured and have limited access.

The custodian will receive the incoming samples and indicate receipt by signing the Sample Chain-of-Custody Record Sheet accompanying the samples and retain the sheet as a permanent record. The custodian should check to ensure that the sample numbers indicated on the Custody Form correspond with the sample jar identification numbers. All incoming samples will be entered into a laboratory sample logbook.

Immediately upon receipt, the custodian will place samples in the sample room which shall be secured at all times except when samples are removed or replaced by the custodian.

The custodian shall maintain the integrity of the samples by appropriate storage and must distribute samples to the personnel who are to perform tests.

The analyst must record information in his laboratory notebook or analytical work sheet, that describes the samples, the procedures performed and the results of the tests. The notes must be retained as a permanent record in the laboratory and should include any abnormalities which occurred during the testing procedure.

Laboratory personnel are responsible for the care and custody of a sample once it is handed over to them and shall be prepared to testify that the sample was in their possession and viewed or secured in the laboratory at all times from the moment it was received from the custodian until the tests were run.

Once the sample testing is completed, the unused portion of the sample together with all identifying tags, laboratory records, and other documentation of work must be returned to the custodian for filing in a secured file location.

5.0 SAMPLE BOTTLE PREPARATION

5.1 CONTAINERS

Sample bottles will be supplied by the analytical laboratory for the collection of all samples. All sample bottles will be precleaned by the laboratory and stored at the sampling site in an area and in manner to prevent breakage and contamination of the cleansed bottles. Trip blanks will be included with bottles shipped to the site.

5.2 CLEANING PROTOCOL

All sample containers to be used for collection of samples for chemical analysis will be precleaned and sealed by the laboratory prior to shipment to the site.

6.0 ANALYTICAL PROTOCOLS

Samples collected as described in the previous sections of this plan will be analyzed for the monitoring parameters in accordance with Test Methods for Evaluating Solid Waste - Physical/Chemical Methods, Third Edition, SW-846, United States Environmental Protection Agency, September 1986.

The monitoring parameters, the method to be utilized and the method detection limits are summarized in Table 2.

TABLE 2

ANALYTICAL PARAMETERS, METHOD AND METHOD DETECTION LIMITS

Parameter	*Method No.*	*Method Detection Limit ug/L*	*USEPA Method Manual*
1,1,1-Trichloroethane	8240	5	SW846
Trichloroethylene	8240	5	SW846
Methylene Chloride	8240	5	SW846
Tetrachloroethylene	8240	5	SW846
Trichlorotrifluoroethane	8240	50	SW846

7.0 LABORATORY QUALITY CONTROL PROCEDURES

Internal quality control procedures for samples analyzed in a manner consistent with SW-846 protocols will be in accordance with those specified by the methods outlined in Table 2.

APPENDIX A

TYPICAL CHAIN-OF-CUSTODY FORM

SHIPPED TO (Laboratory name):

CHAIN OF CUSTODY RECORD

PROJECT Nº:

PROJECT NAME:

SAMPLER'S SIGNATURE _____ (SIGN)

SEQ. Nº.	SAMPLE Nº.	DATE	TIME	SAMPLE LOCATION	SAMPLE TYPE	Nº OF CONTAINERS	REMARKS
				TOTAL NUMBER OF CONTAINERS			

ANTICIPATED CHEMICAL HAZARDS:

RELINQUISHED BY:	DATE/TIME	RECEIVED BY:
[1] (SIGN)		(2) (SIGN)
RELINQUISHED BY: [2] (SIGN)	DATE/TIME	RECEIVED BY: (3) (SIGN)
RELINQUISHED BY: [3] (SIGN)	DATE/TIME	RECEIVED BY: (4) (SIGN)
RELINQUISHED BY: [4] (SIGN)	DATE/TIME	RECEIVED BY: (5) (SIGN)
RELINQUISHED BY: [5] (SIGN)	DATE/TIME	RECEIVED BY: (6) (SIGN)
RELINQUISHED BY: [6] (SIGN)	DATE/TIME	RECEIVED BY: (7) (SIGN)
RELINQUISHED BY: [7] (SIGN)	DATE/TIME	RECEIVED BY: (8) (SIGN)

METHOD OF SHIPMENT:	SHIPPED BY:	RECEIVED FOR LABORATORY BY: (SIGN)	DATE/TIME
CONDITION OF SEAL UPON RECEIPT: GENERAL CONDITION OF COOLER:		COOLER OPENED BY: (SIGN)	DATE/TIME

WHITE – CRA OFFICE COPY
YELLOW – RECEIVING LABORATORY COPY
PINK – CRA LABORATORY COPY
GOLDENROD – SHIPPERS

ATTACHMENT E5

ATTACHMENT E-5

STATISTICAL TESTING PROCEDURE

STATISTICAL TESTING PROCEDURES

The following is a description of the statistical testing procedure which will be used to provide a reliable indication of the presence of hazardous waste constituents in the groundwater passing the point of compliance. This procedure is in basic accord with the procedures outlined in the MDNR-approved American Cyanamid Co. Act 64 Permit Application. The concentrations of the compliance point wells will be statistically compared to the background data from the upgradient monitoring as described below.

The tests described are statistical techniques for comparing two sets of data and making a determination whether there is a significant difference between them. In some cases, a set of observations from an upgradient well is compared with a set of observations from a downgradient well (or wells). In other cases, historical data are compared with current data. The term background will be used in referring to the set of upgradient or historical data and the term foreground in referring to the downgradient or current data.

The following discussion presents:

I. The RCRA t-test and some of the weaknesses of this test;

II. The t-test with Continuity Correction which will be used in specific situations.

In many cases, the use of an alternative procedure to Cochran's Approximation to the Behrens-Fisher t-test is necessary because the basic statistical procedure is inappropriate. Problems arise:

i) where the parameter is at, or near, the detection limit. When a series of values for a parameter are determined as 'less than the detection limit', estimation of the mean and the variance is difficult. Also, because of the precision of laboratory instruments and methods, there are only a small number of possible values which the laboratory techniques may generate. In such a situation, the rounding caused by the level of precision of the analytical techniques results in a poor estimation of the variance;

ii) even when the values for a parameter are considerably above the detection level, it may be the case that the scale of observation is too discrete for the correct use of a t-test. The problem arises when the

normal variations in the parameter are of the same order of magnitude as the minimal analytically-detectable change;

iii) in some cases, the situation arises in which the observations in at least one of the two data sets being compared are either constant, or so close to being constant that it is not possible to get a good estimate of the variance for the population from which the observations are being drawn.

The t-test with continuity correction is designed as a test to correct for some of the difficulties with Cochran's Approximation to the Behrens-Fisher Student's t-test. Thus, Cochran's Approximation to the Behrens-Fisher t-test will be used with two adjustments:

i) the variance of S^2, of each data set will be computed in a manner that takes into account the fact that each data point represents a range of possible values rather than a single precisely-determined real number;

ii) a lower limit to the standard error of the mean will be used to prevent it from decreasing beyond the precision of the analytical precision, thus preventing the standard error from inflating the t-statistic.

For purposes of calculation, if one-quarter of the measurements at a sampling location are reported as below the level of quantification, a value of three-quarters of the level of quantification will be used in lieu of these 'less than' values; if one-half of the measurements are reported as below the level of quantification, a value of one-half of the level of quantification will be used in lieu of the 'less than' values; if three-quarters or more of the measurements are reported as 'less than' values, value of one-quarter of the level of quantification will be used in lieu of the 'less than' values.

When an observation is below the minimum detection limit (MDL), the value of Δ_i will be set as $\Delta_i = MDL/2$. If an observation is at or above the level of quantification, the value for Δ_i will be set as Δ_i = one-half the difference between the next possible higher observed value and X_i (determined by the analytical process and instrumentation).

The mean of a set of values X_i, ... X_n will then be computed by

$$\bar{X} = \sum_{i=1}^{N} Xi/N$$

and the variance S^2 will be computed by

$$S^2 = \frac{1}{N-1} \sum_{i=1}^{N} [Xi-\bar{X})^2 + \frac{1}{3}\Delta_i^2]$$

The variance of the mean, W will be computed as S^2/N. W will be compared with the quantity

$$\text{LL VOM} = \frac{1}{N} \sum_{i=1}^{N} \left[\frac{\Delta_i}{2}\right]^2$$

If the computed W is less than LLVOM, it will be replaced by LLVOM.

Except for these modifications, the RCRA t-test computational procedure will be unchanged. After the mean and variance have been computed as described, the Cochran's Approximation to the Behrens-Fisher Student's t-test will be used with confidence level 0.01.

Let Nb = the number of background observations and N_m = the number of foreground observations. From the background and foreground data, the background mean, X_b, the foreground mean, X_m, the background variance S_b^2, the foreground variance, S_m^2, and the variance of the estimator of the background mean, W_b, and the variance of the estimator of the foreground mean, W_m, will be computed. From this information, the t-statistic will be computed as

$$t^* = \frac{|\bar{X}_m - \bar{X}_b|}{\sqrt{W_m + W_b}}$$

Calculation of the comparison t-statistic (t_c) against which t* will be compared necessitates first computing t_b and t_m from standard one-tailed tables where:

t_b = value of t from t-table with N_B -1 degrees of freedom and confidence level 0.01;

t_m = value of t from t-table with N_M -1 degrees of freedom and confidence level 0.01.

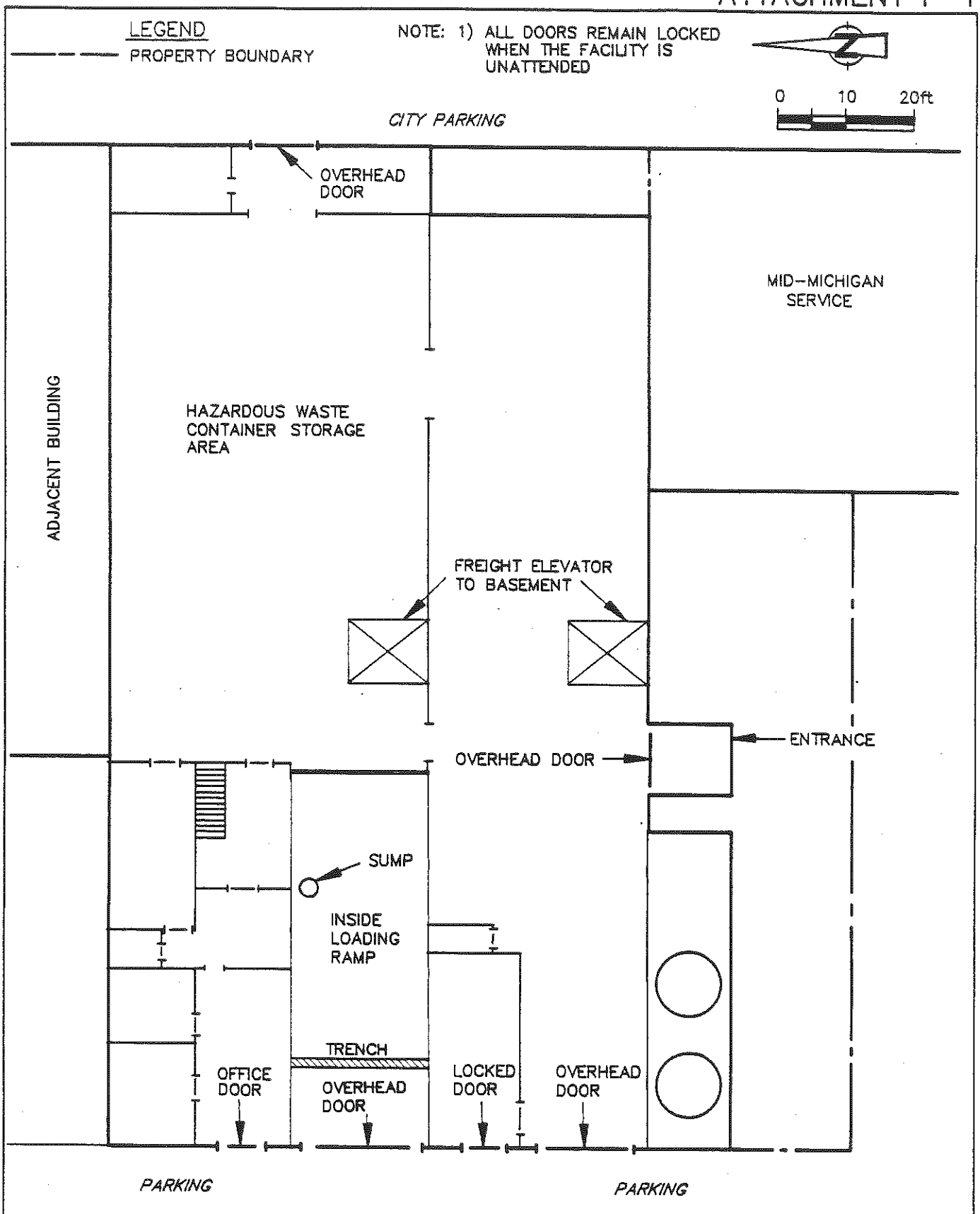
The comparison t-statistic t_c is

$$tc = \frac{w_b t_b + W_m t_m}{W_b + W_m}$$

The t-statistic, t*, will then be compared with the comparison t-statistic, t_c, using the following decision rule:

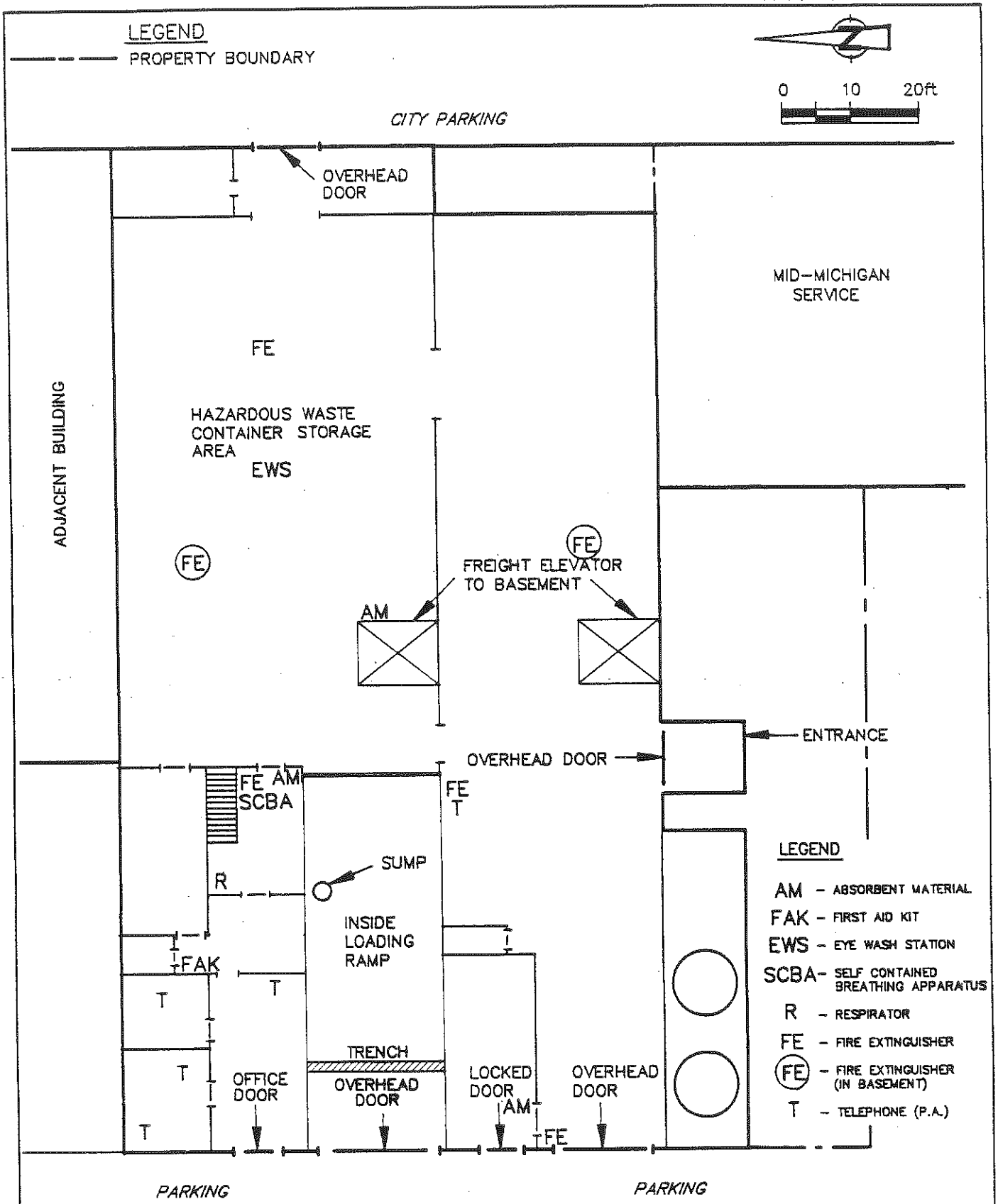
If t* is greater than or equal t_c then the null hypothesis, H_0 is rejected, H_1 is accepted, and the foreground mean is found to be greater than the background mean.

However, if t* is less than t_c then the foreground mean is not found to exceed the background mean and the null hypothesis, H_0 is maintained. The foreground mean is found to not be greater than the background mean.



SECURITY PRECAUTIONS
Detrex Corporation
Gold Shield Solvents, Grand Rapids

CRA



LOCATION OF EMERGENCY AND SAFETY EQUIPMENT

Detrex Corporation

Gold Shield Solvents, Grand Rapids

CRA

2471-26/10/88-6-D-7 (B-2)

LIST OF TABLES

LIST OF ATTACHMENTS

TABLE G-2

EMERGENCY RESPONSE AGENCIES/ORGANIZATIONS

Name	Phone Number
Police Department	911 (616-456-3405)
Fire Department	911 (616-456-3900)
Butterworth Hospital	(616) 774-1680
St. Mary's Hospital	(616) 774-6090
National Response Center	800-424-8802
Detrex Corporation Risk Management Group	(313) 358-5800
Michigan Pollution Emergency Alerting System	800-294-4706
State EPA	(616) 456-5071
Emergency Spill Clean-Up Companies	
- Mid-America	(616) 281-3090 (800) 382-2769
- Valley City Disposal	(616) 235-1500

G-5 EMERGENCY EQUIPMENT [40 CFR §264.52(e)]

The type and physical location of Gold Shield Solvents' emergency equipment, including fire equipment, spill control equipment breathing apparatus and medical treatment facilities is presented in Attachment G-2. A brief discussion of each aspect of the Emergency Equipment follows.

1) Communications System

- telephone/public address system: Merlin (AT&T)

2) Fire Control Systems and Equipment

- fire extinguishers: 5 lb. ABC
- fire hydrants

3) Spill Control Equipment

- absorbent material: Oil-Dri Industrial Absorbent, (ground clay)

4) Health and Medical Emergency Equipment/Supplies

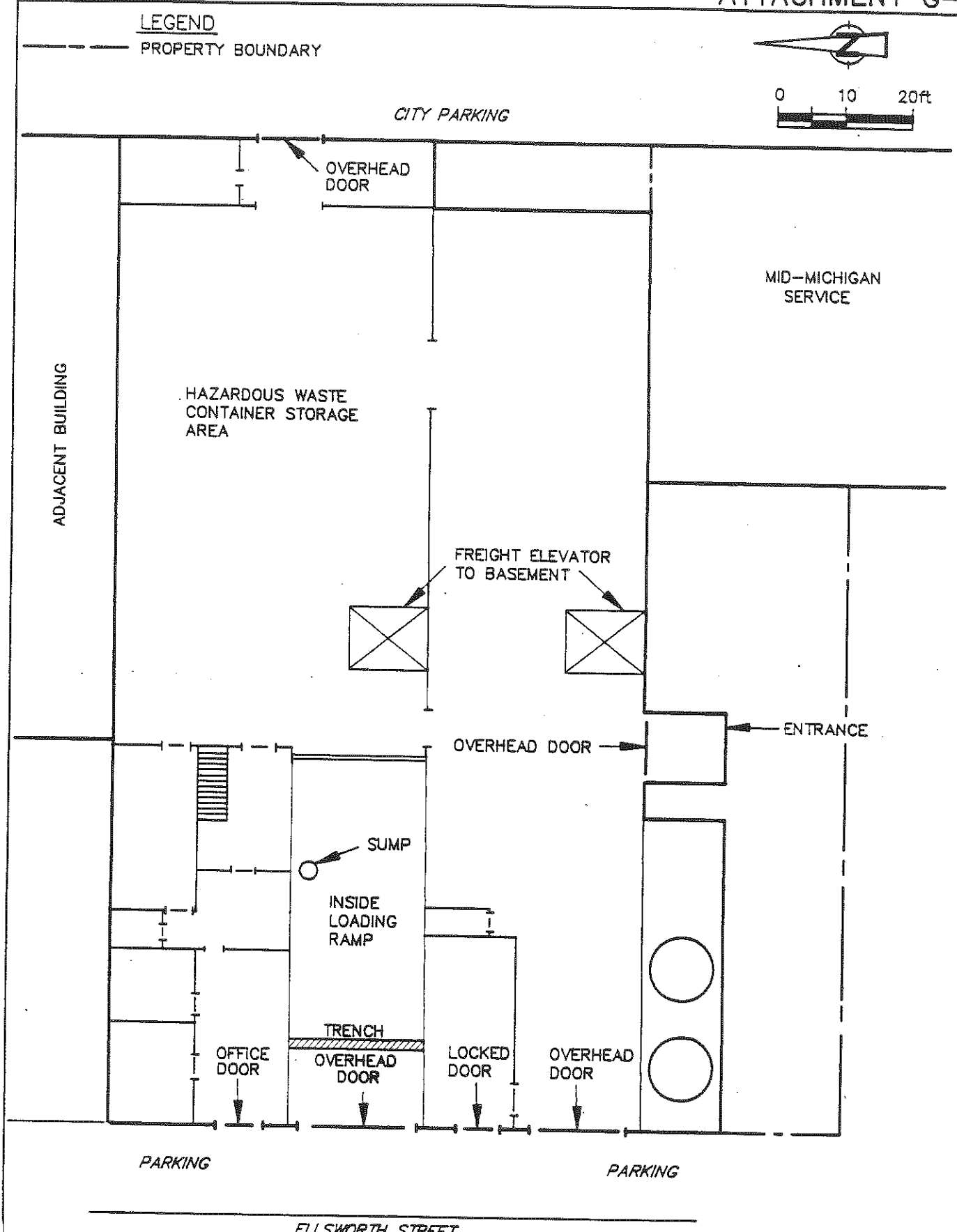
- respirators: half-face with permissible chemical cartridges for atmospheres containing less than 1,000 ppm organic vapors
- self-contained breathing apparatus: SCOTT AIR-PAKII, 30 min. air supply, equipped with pak alarm warning of low air, good to -25°F
- eye wash: 3 portable 16 fl. oz. acid and alkali neutralizers for eyes and skin
- first-aid: RESPOND© SYSTEMS First Aid Kit meeting OSHA requirements
- safety goggles
- gloves

G-6 COORDINATION AGREEMENTS [40 CFR §264.37/§264.52(c)]

To familiarize police, fire department, hospital officials and other emergency response agencies with the layout of the facility, properties of the hazardous wastes handled at the facility and associated hazards, entrances to the facility, possible evacuation routes, and other aspects of the Gold Shield Solvents facility, copies of the contingency plan and waste characteristic information are submitted to the appropriate officials.

Each person, or the chief officer of each department, which receives a copy of the contingency plan is asked to sign a Coordination Agreement form to acknowledge that he/she reviewed the plan, understood the department's role under the plan, and that all members of the department will be informed of the plan's content and their individual responsibilities. Any persons wishing to meet with a representative of Detrex Corporation, to review the contingency plan and waste characteristic information, may indicate so on the agreement form. A copy of the agreement form is presented in Attachment G-4. Signed agreements are maintained on file in the office.

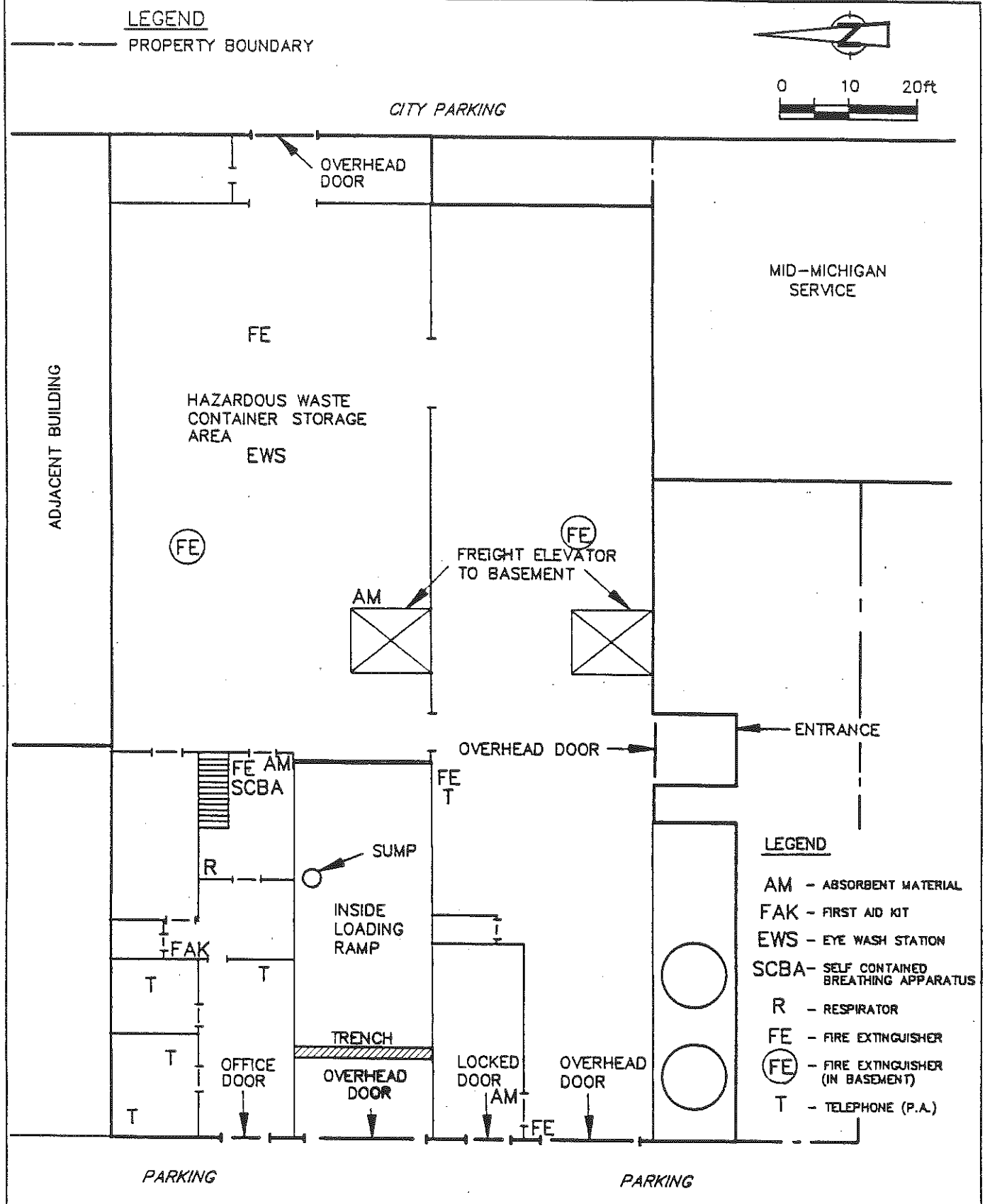
ATTACHMENT G-1



FACILITY PLAN
Detrex Corporation
Gold Shield Solvents, Grand Rapids

CRA

2471-4/11/88-6-D-1



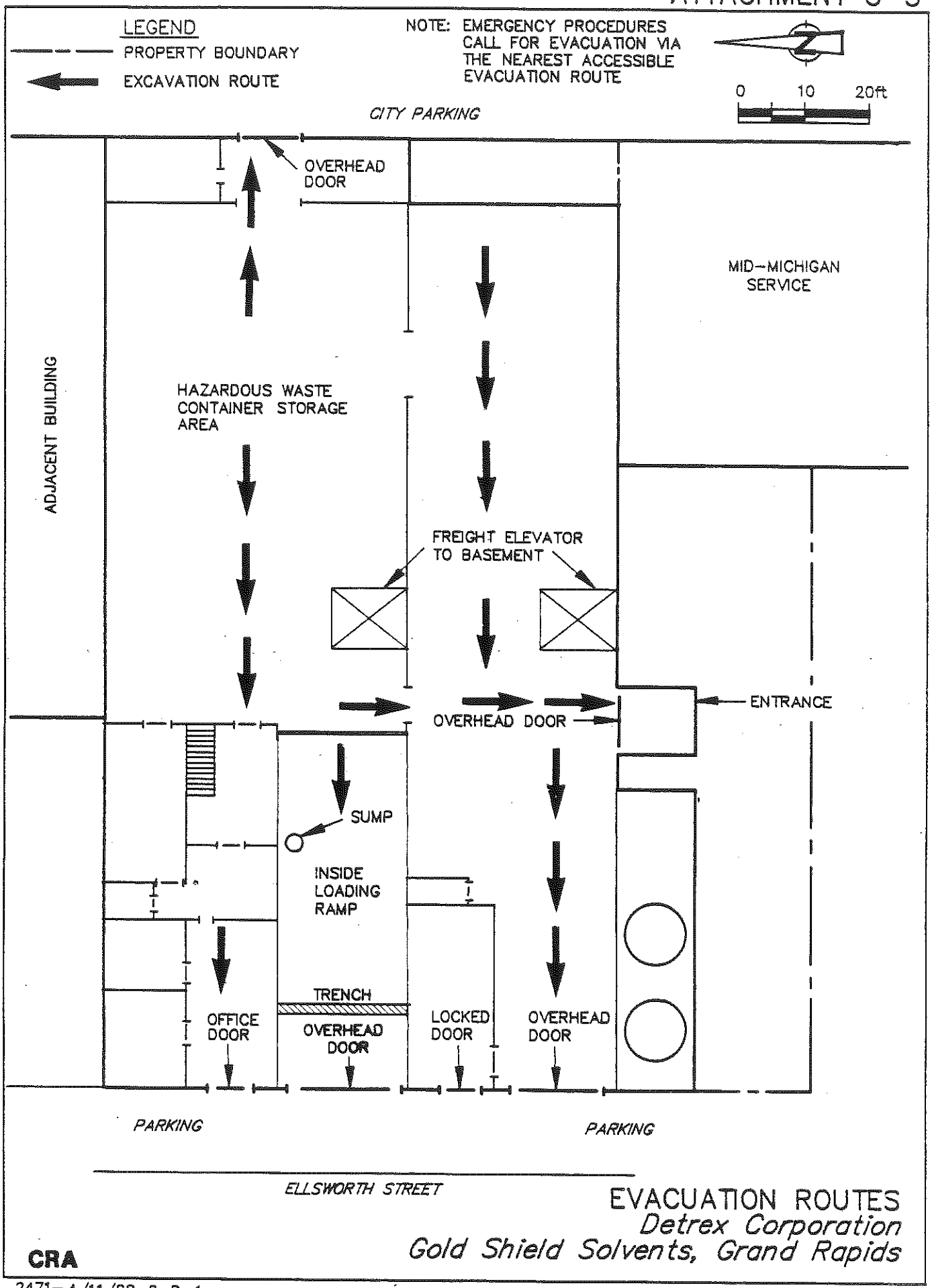
LOCATION OF EMERGENCY AND SAFETY EQUIPMENT

Detrex Corporation

Gold Shield Solvents, Grand Rapids

CRA

2471-26/10/88-6-D-7 (B-2)



EVACUATION ROUTES
Detrex Corporation
Gold Shield Solvents, Grand Rapids

CRA

2471-4/11/88-6-D-1

ATTACHMENT G-4

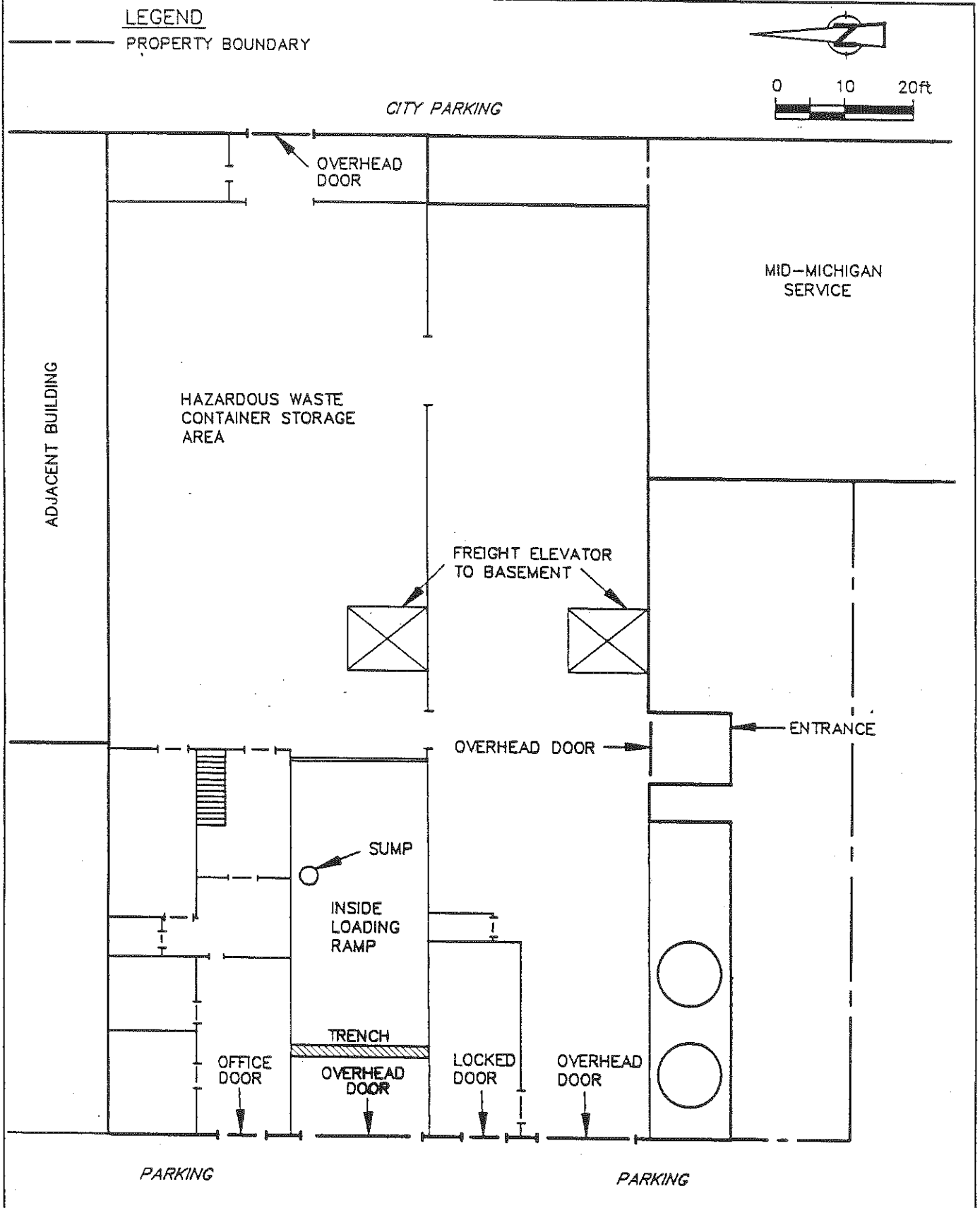
COORDINATION AGREEMENT

Coordination Agreement

I _____ an authorized representative
of _____ have received a copy of the
Contingency Plan, waste characterization and MSDS for waste/material handled at
Detrex Corporation's Gold Shield Solvent facility branch
in _____.

I wish to discuss the contents of the information with a representative of Detrex Corporation (Y/N):_____. A copy of the information will be kept on file to aid in emergency procedures.

_____	_____	_____
Signature	Emergency Response Organization	Date
_____	Detrex Corporation	_____
Signature	Gold Shield Solvents	Date



FACILITY PLAN
Detrex Corporation
Gold Shield Solvents, Grand Rapids

CRA

2471-4/11/88-6-D-1

ATTACHMENT I-4

FINANCIAL ASSURANCE MECHANISM AND LIABILITY INSURANCE

DETREX CORPORATION

P.O. Box 5111, Southfield, MI 48086-5111

TWX 810-224-4756

TELEPHONE:
(313) 358-5800

March 31, 1989

Michigan Department of Natural Resources
Hazardous Waste Division
P. O. Box 30028
Lansing, MI 48909

Re: Financial Requirements - Annual Report

Dear Sir or Madam:

Enclosed is the following for our Michigan facilities at:

12886 Eaton Avenue — EPA #MID 09 160 5972
Detroit, MI 48227

312 Ellsworth Avenue, S.W. — EPA #MID 02 090 6764
Grand Rapids, MI 49503

1) A letter by our chief financial officer

2) Our 1988 Annual Report

3) A statement by our independent Certified Public Accountant

Should you have any questions, please call me.

Very truly yours,

W. G. Robrecht
Safety and Loss Prev. Administrator

WGR/smb

Encl.

cc: M. J. Tepatti

DETREX CORPORATION

P.O. Box 5111, Southfield, MI 48086-5111

TWX 810-224-4756

TELEPHONE:
(313)358-5800

March 31, 1989

Michigan Department of Natural Resources
Hazardous Waste Division
P. O. Box 30028
Lansing, MI 48909

I am the chief financial officer of Detrex Corporation, P. O. Box 5111, Southfield, MI 48086. This letter is in support of the use of the financial test to demonstrate financial responsibility for liability coverage and closure, as specified in Part 7 of the Act 64 Administrative Rules.

1. This firm is the owner or operator of the following facilities for which liability coverage is being demonstrated through the financial test specified in Subpart H of 40 CFR 264:

Region	Facility	EPA Identification
I	Gold Shield Division 260 Chapel Road So. Windsor, CT 06074	CTD 01 016 8870
II	Gold Shield Division 835 Industrial Highway Unit No. 1 Cinnaminson, NJ 08077	NJD 04 731 8043
IV	Gold Shield Division P. O. Box 5274 Charlotte, NC 28225	NCD 04 977 3245
V	Gold Shield Division 12886 Eaton Avenue Detroit, MI 48227	MID 09 160 5972
V	Gold Shield Division 312 Ellsworth Avenue, S.W. Grand Rapids, MI 49503	MID 02 090 6764
V	Gold Shield Division 1410 Chardon Road Euclid, OH 44117	OHD 08 015 8702

Region	Facility	EPA Identification
V	Gold Shield Division 2537 LeMoyne Avenue Melrose Park, IL 60160	ILD 07 442 4938
V	Gold Shield Division 2263 Distributors Drive Indianapolis, IN 46241	IND 08 561 6837
V	General Chemicals Division North State Road Ashtabula, OH 44004	OHD 00 416 5924
VI	Gold Shield Division 322 International Parkway Arlington, TX 76011	TXD 98 062 6154
IX	Gold Shield Division 3027 Fruitland Avenue Los Angeles, CA 90058	CAD 02 016 1642

2. This firm owns or operates the following facilities for which financial assurance for closure is demonstrated through the financial test specified in Part 7 of the Act 64 Administrative Rules. The current closure cost estimates covered by the test are shown for each facility:

Region	Facility	EPA Identification	Closure Cost
I	Gold Shield Division 260 Chapel Road So. Windsor, CT 06074	CTD 01 016 8870	$ 23,595
II	Gold Shield Division 835 Industrial Highway Unit No. 1 Cinnaminson, NJ 08077	NJD 04 731 8043	Via Trust Fund
IV	Gold Shield Division P. O. Box 5274 Charlotte, NC 28225	NCD 04977 3245	30,748
V	Gold Shield Division 12886 Eaton Avenue Detroit, MI 48227	MID 09 160 5972	17,335
V	Gold Shield Division 312 Ellsworth Avenue, S.W. Grand Rapids, MI 49503	MID 02 090 6764	11,322
V	Gold Shield Division 1410 Chardon Road Euclid, OH 44117	OHD 08 015 8702	22,120

Region	Facility	EPA Identification	Closure Cost
V	Gold Shield Division 2537 LeMoyne Avenue Melrose Park, IL 60160	ILD 07 442 4938	$ 36,775
V	Gold Shield Division 2263 Distributors Drive Indianapolis, IN 46241	IND 08 561 6837	58,602
V	General Chemicals Division North State Road Ashtabula, OH 44004	OHD 00 416 5924	42,800
VI	Gold Shield Division 322 International Parkway Arlington, TX 76011	TXD 98 062 6154	176,951
IX	Gold Shield Division 3027 Fruitland Avenue Los Angeles, CA 9005	CAD 02 016 1642	37,846
			$458,094

3. This firm guarantees, through the corporate guarantee specified in Part 7 of the Act 64 Administrative Rules, the closure and post-closure care of the following facilities owned or operated by its subsidiaries. The current cost estimates for the closure or post-closure care so guaranteed are shown for each facility: None.

4. In states where EPA is not administering the financial requirements of Subpart H of 40 CFR Parts 264, this owner or operator is demonstrating financial assurance for the closure or post-closure care of the following facilities through the use of a test equivalent or substantially equivalent to the financial test specified in Subpart H of 40 CFR Parts 264. The current closure and/or post-closure cost estimates covered by such a test are shown for each facility: as noted above.

5. In states where EPA is administering the financial requirements of Subpart H of 40 CFR Part 264, this firm, as owner or operator or guarantor, is demonstrating financial assurance for the closure or post-closure care of the following facilities through the use of the financial test specified in Subpart H of 40 CFR Part 264. The closure and/or post-closure cost estimates covered by this test are shown for each facility: As noted above.

6. This firm is the owner or operator of the following hazardous waste management facilities for which financial assurance for closure or, if disposal facility, post-closure care, is not demonstrated either to EPA or a State through the financial test or any other financial assurance mechanism specified in Subpart H of 40 CFR Parts 264 or equivalent or substantially equivalent State mechanisms. The current closure and/or post-closure cost estimates are not covered by such financial assurance are shown for each facility: None.

This firm is required to file a Form 10K with the Securities and Exchange Commission (SEC) for the latest fiscal year.

The fiscal year of this firm ends on December 31. The figures for the following items marked with a asterisk are derived from this firm's independently audited, year-end financial statements for the latest completed fiscal year, ended 1988.

1.	Sum of current closure cost estimates (total of all cost estimates listed above)	$ 458,094
2.	Amount of annual aggregate liability coverage to be demonstrated	2,000,000
3.	Sum of lines 1 and 2	2,458,094
*4.	Total liabilities (if any portion of the closure cost estimates is included in total liabilities, you may deduct the amount of that portion from this line and add that amount to lines 5 and 6)	20,776,339
*5.	Tangible net worth	41,659,274
*6.	Net worth	42,364,170
*7.	Current assets	39,268,032
*8.	Current liabilities	12,248,458
*9.	Net working capital (line 7 minus line 8)	27,019,574
*10.	The sum of net income plus depreciation, depletion and amortization	6,359,288
*11.	Total assets in U.S. (required only if less than 90% of firm's assets are located in the U.S.)	N/A
*12.	Total assets in Michigan, excluding the value of land used for hazardous waste disposal	44,510,852

		Yes	No
13.	Is line 5 at least $10 million?	X	
14.	Is line 5 at least 6 times line 3?	X	
15.	Is line 9 at least 6 times line 3?	X	

		Yes	No
*16.	Are at least 90% of firm's assets located in the U.S.? If not, complete line 17	X	
17.	Is line 11 at least 6 times line 1?	N/A	
18.	Is line 4 divided by line 6 less than 2.0?	X	
19.	Is line 10 divided by line 4 greater than 0.1?	X	
20.	Is line 7 divided by line 8 greater than 1.5?	X	
*21.	Is line 12 at least $50 million?		X
22.	Is line 12 at least 6 times line 1?	X	

I hereby certify that the wording of this letter is identical to the wording in the model letter specified by the Director for the financial test related to closure/post-closure care as well as liability insurance coverage, as such letter was specified on the date shown immediately below.

Very truly yours,

C. B. Stockmeyer, Jr.
Vice President & Treasurer

March 31, 1989

/smb

Deloitte
Haskins—Sells

Suite 3100
100 Renaissance Center
Detroit, Michigan 48243-1167
(313) 446-0100
ITT TIMETRAN: 4994951

INDEPENDENT AUDITORS' REPORT

Detrex Corporation:

We have audited, in accordance with generally accepted auditing standards, the consolidated financial statements of Detrex Corporation and its subsidiaries for the year ended December 31, 1988, and have issued our report thereon dated February 28, 1989. We have not performed any auditing procedures beyond the date of our report on the consolidated financial statements; accordingly, this report is based on our knowledge as of that date and should be read with that understanding.

At your request, we have performed the procedures enumerated below with respect to the accompanying letter from C. B. Stockmeyer, Jr. to the Michigan Department of Natural Resources - Hazardous Waste Division dated March 31, 1989. It is understood that this report is solely for filing with the Michigan Department of Natural Resources - Hazardous Waste Division in accordance with requirements of the Michigan Administrative Rules, and is not to be used for any other purpose. The procedures that we performed are summarized as follows:

1. We compared the amounts included in items 6 through 8 on page 4 in the letter referred to above with the corresponding amounts in the consolidated financial statements referred to in the first paragraph.

2. We recomputed from, or reconciled to, the consolidated financial statements referred to in the first paragraph the information included in items 4, 5, 9 through 12, 16 and 21 on pages 4 and 5 in the letter referred to above.

Because the procedures referred to in the preceding paragraph were not sufficient to constitute an audit made in accordance with generally accepted auditing standards, we do not express an opinion on any of the information or amounts listed on pages 4 and 5 in the aforementioned letter. In performing the procedures referred to above, however, no matters came to our attention that caused us to believe that the information or amounts included in items 4 through 12, 16 and 21 should be adjusted.

Deloitte Haskins & Sells

March 31, 1989

J-2 DESCRIPTION OF EXISTING ENVIRONMENT

The Gold Shield Solvents facility is located in Grand Rapids, Michigan at 312 Ellsworth Avenue. The site location is shown in Attachment J-1.

The following sections provide a description of the existing environment in the vicinity of the Gold Shield Solvents facility. Attachment J-2 provides a list of references used in preparing this environmental description.

J-2a Physiography

J-2a(1) Topography

The surface topography in southwestern Michigan was greatly affected by the Wisconsian glaciation of the late Pleistocene Epoch. The region exhibits many glacial features including various recessional moraines, lake plains, outwash plains and outwash channels.

During the latter part of the Wisconsian glaciation, southwest Michigan was influenced by two retreating ice lobes. Differing rates of recession resulted in various degrees of development of the surficial deposits. In total, five major end moraines can be evidenced in southwestern Michigan. As recession began, an interlobate moraine was produced by both the Saginaw and Michigan ice lobes. Continued recession resulted in the formation of four more major end moraines; two by the Saginaw ice lobe and two by the Michigan ice lobes.

Kent County, wherein the Gold Shield Solvents facility is located, is comprised of the various glacial features mentioned above. In southwest Kent County, the Lake Michigan-Saginaw Interlobe tract reaches an elevation of 1,032 feet above mean seal level at Dias Hill (just SW of the Grand Rapids International Airport). At such an elevation, this interlobe structure stands more than 100 feet above the other area moraines. West of the interlobe, elevations generally decrease with the presence of smaller moraines, extensive outwash plains, and outwash channels. Low lying areas are occupied by marshes and rivers.

The Gold Shield Solvents facility area lies at an elevation of approximately 625 feet above sea level. Just west of this facility is the Grand River which is at an elevation of 585 feet above sea level. A substantial ridge runs north and south between the Gold Shield facility and the river. The topography to the east of the ridge slopes downward towards the Gold Shield Solvents facility and the nearby expressway.

J-2a(2) Geology

The Gold Shield Solvents facility is situated on an assortment of stratified outwash deposits. A detailed description of the geology in the vicinity of the facility is presented in Attachment E-1 of this operating license application.

The overburden in general, composed of various sandy deposits, represents good aquifer potential for water supplies. In 1981, Kent County recorded 18 wells within the glacial drift aquifers (USEPA 1981). Cedar Springs, Grand Rapids Township and Wyoming Township reported water wells located within the glacial drift deposits with supply capacities as high as 1,000 gpm.

Beneath the above mentioned glacial drift overburden, lies a sequence of important bedrock formations. The downward sequence of the various formations include the following:

Pennsylvanian Period

Saginaw Formation

The shallowest bedrock formation, the Saginaw, is an important aquifer in much of the central and eastern parts of the Lower Peninsula. This formation is characterized as being primarily sandstone and siltstone with interbedded layers of shale, limestone, coal and gypsum. Naturally with these materials, there exists a wide range of porosities for this unit. The lenticular shaly sandstones tend to have a low effective porosity whereas the clean sandstone bodies have a much higher effective porosity. As a water supply aquifer, the Saginaw formation has a very good yield mainly in the upper portions of the unit. The transmissivity of the Saginaw is greater in the upper portions of the unit primarily due to increased fracturing at the bedrock surface. Transmissivities range anywhere from 9,520 gpd/ft to 37,156 gpd/ft.

A detailed description of the hydrogeology, in the vicinity of the facility, is presented in Attachment E-1 of this operating license application.

J-2f Air Quality

The Gold Shield Solvents facility is an existing industrial operation in a light industrial zone within Grand Rapids. A Grand Rapids air quality summary that was taken from the Michigan Department of Natural Resources "Air Quality Report - 1986", outlines air quality from 1979 to 1986 and is presented below.

> The total suspended particulate sampling network in the Grand Rapids area consists of seven samplers. Grand Rapids has demonstrated compliance with annual and 24-hour primary standards for well over ten years. Since 1979, the 24-hour secondary standard has also been met.
>
> A PM10 monitor, one which measures particulate matter 10 microns or less, operates at the Grand Rapids downtown water pumping station monitoring location. The annual arithmetic mean for January through December was 31 ug/m^3.
>
> As in the previous years, the continuous analyzers for sulfur dioxide and carbon monoxide located in downtown Grand Rapids have recorded levels below the established standards.
>
> Two ozone monitoring sites operated in Kent County in 1986: one in downtown Grand Rapids and the other at a site located approximately 15 miles northeast of the Grand Rapids urban area. Neither site recorded an excursion of the .12 ppm standard in 1986. Both sites recorded excursions of the .12 ppm ozone standard in 1985. During 1984, only the downtown Grand Rapids site recorded an excursion of the standard. During 1983, both sites again recorded excursions of the ozone standard. The downtown site alone exceeded the standard in 1982, and no excursions were recorded at either site back to 1979.

The analysis for lead at two sites in Grand Rapids indicated the sites met the calendar-quarter lead standard, as in the past six years. One site is a roadway site, installed along an expressway in 1981, designed to record high concentrations of lead.

A monitoring stations map has been included as Attachment J-4 and the most recently published (1986) air quality data has been summarized on Table J-5.

J-2g Aesthetics

The area in which the Detrex Corporation Gold Shield Solvents facility is located is an industrial area of Grand Rapids. The aesthetic value of this area is somewhat limited.

The facility is not a source of unreasonable noise or other nuisance factors. The amount of truck traffic to and from this facility is not inconsistent with other industries in the area. Traffic information, in relation to the movement of hazardous wastes, is discussed in Section B of this operating license application.

J-2h Land Use

Existing land use and zoning in the site area is shown on Attachment J-5. The facility is located in a light industrial district (I-1) adjacent to the central business district zone (CBD-4).

J-2i Archaeological and Historical Resources and Site

The Gold Shield Solvents facility is an existing industrial operation in an industrial area. The site is currently being reviewed by representatives of the Michigan Department of State, Michigan History Division. The result of their review will be amended to the operating license application when available.

J-7 FAILURE MODE ASSESSMENT

J-7a Description of System

The Detrex Corporation Gold Shield Solvents hazardous waste handling system consists of receiving drummed solvent wastes generated in degreasing and other cleaning operations, storing the wastes in a secure container storage area within the single enclosed building, and transferring the solvent wastes to an off-site Detrex solvent recovery (recycling) operation or to an off-site permitted treatment/disposal facility.

J-7b Definition of Failure

A failure within the container storage area could occur as a leakage of liquids from the drums.

A failure during on-site transport at the indoor concrete loading/unloading area could also occur as either a leakage of liquids from the drums during transfer from the truck to the container storage area.

J-7c Possible Causes of Failure

The potential failure mode could occur from poorly sealed drums, drums of poor structural integrity, or drums that are accidentally punctured or in some other manner damaged during handling operations.

J-7d Methods for Detection of Failure

The possible modes of failure presented above would either be detected during regular inspections of the container storage and secondary containment area or immediately identified by plant personnel during transfer operations at the loading/unloading area. The container storage area is located within the single building. As such, plant personnel are in or near the container storage area during all plant operating hours.

The facility inspection schedule is presented in more detail in Section F of this operating license application.

J-7e Environmental Effects of Failure

The possible mode of failure presented in previous sections could cause a release of hazardous waste onto the facility floor and secondary containment area and/or

onto the loading/unloading ramp area, in the enclosed structure. The secondary containment area and the loading/unloading area are constructed of concrete to provide secure secondary containment for the capture of any potentially released material.

J-7f Possible Corrective Actions in the Event of Failure

A detailed description of the response actions that will be implemented in the event of a failure is presented in Section G (Contingency Plan) of this operating license application. Section G-4b(2) details the response in the event of an accidental release of liquids. Procedures to prevent the occurrence of hazards are described in Section F (Preparedness and Prevention Procedures).

In summary, the Preparedness and Prevention Procedures (Section F) addresses the following:

- Security
- Inspection requirements and schedule
- Emergency equipment
- Emergency prevention

The Contingency Plan addresses the following:

- Emergency Coordinators
- Notification, identification and assessment
- Control procedures
- Response Procedures
- Emergency procedures
- Evacuation plan

LIST OF TABLES

LIST OF ATTACHMENTS

was removed, and the tanks cleaned. The tanks were constructed of carbon steel, however, specifications are not available. The tanks were used to store any of the F002 wastes listed on Table K-1. The dimensions and capacity of each tank are summarized as follows:

Tank No.	Capacity (gal.)	Dimensions (LxWxH)
1	300	48 1/4" x 32 1/4" x 48 1/4"
2	500	72 1/4" x 36 1/4" x 48 1/4"
3	500	72 1/4" x 36 1/2" x 48"
4	350	48 1/4" dia. x 42 1/2" long
5	905	80 1/2" x 39" x 70"
6	905	80 1/2" x 39" x 70"
7	905	80 1/2" x 39" x 70"
Total	4,365	

The MDNR requested in a letter dated November 20, 1988, addressed to Detrex Corporation, that a closure plan must be submitted for the two generator accumulation tanks that were initially included under Detrex's interim status as storage tanks. In response to the MDNR's request and subsequent requests for a closure plan for inactive container storage areas, Detrex Corporation has submitted a plan of closure for the two storage tanks and the inactive hazardous waste container storage areas. The Plan of Closure is presented in Attachment K-4.

K-1a(5) Inactive Container Storage Areas

Hazardous wastes were historically stored in containers in areas other than discussed in Section K-1a(1). As with the existing container storage area, the inactive areas were located entirely within the enclosed building structure with similar secondary containment. The inactive container storage areas are located on Attachment K-1b. These areas were in operation from 1970 to 1987, at which time their inventory was transferred to the active container storage area or shipped off-site for recycling a list of the hazardous wastes which may have been stored in these areas is presented in Table K-1. As discussed above, a Plan of Closure for the inactive container storage areas is presented in Attachment K-4.

K-1a(6) Inactive Waste Handling Area

Still bottoms were historically transferred from the generator accumulation tank via above ground piping to tankers at the back of the facility. The loading area is shown on Attachment K-1b. There was no secondary containment provided in this area. Loading in this area was conducted from 1970 to 1986. Wastes which were loaded in this area consisted of the F002 wastes listed on Table K-1.

K-2 RELEASES

K-2a Characterize Releases

There have been no known releases from any of the solid waste management units in operation at the Gold Shield Solvents facility in Grand Rapids, Michigan, with the exception of a release near the inactive waste handling area at the back of the building and potential releases along the south side of the building.

In 1985, the MDNR discovered drippings from a pipe located at the back of the building. An initial investigation was conducted by Gold Shield Solvents which identified the presence of solvents in the soils. Gold Shield Solvents subsequently prepared, submitted and received approval from the MDNR on a Work Plan to determine the horizontal and vertical extent of soil contamination. A copy of the work plan is enclosed as Attachment K-2. Results of the investigation are presented in the report enclosed as Attachment K-3. Based on the results of the investigation, Gold Shield Solvents excavated and disposed off-site approximately 300 cubic yards of soil in 1986, as agreed to with the MDNR.

Also, in 1988, during an excavation on the adjacent property owned by Mid-Michigan Services, trichloroethylene and other halogenated volatile organic compounds were found in soil samples collected from within the excavation. Based on these findings, the MDNR requested Detrex to develop a work plan outlining the extent of the area of contamination adjacent to their facility. The MDNR-approved work plan and subsequent site investigation work plan are presented as Appendix A and Appendix B, respectively, in Attachment K-4. The site investigation report has been submitted to the MDNR for their review.

F

SECTION F

PROCEDURES TO PREVENT HAZARDS

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LIST OF ATTACHMENTS

SECTION F

PROCEDURES TO PREVENT HAZARDS

This section of the operating license application provides a description of the procedures implemented at the Gold Shield Solvents facility to prevent the possibility of a hazard from occurring.

This information is provided pursuant to Michigan Act 64 Rule 299.9504(1)(c) which incorporates 40 CFR 270.14(b)(4),(5),(6),(8), and (9) by reference. The applicable section(s) of the Federal Regulations (40 CFR) is referenced as appropriate.

F-1 FACILITY SECURITY [40 CFR §264.14/§270.14(b)(4)]

F-1a Security Procedures and Equipment [40 CFR §270.14(b)(4), §264.14]

F-1a(1) 24-Hour Surveillance System [40 CFR 264.14(b)(1)]

A 24-hour surveillance system or continuous surveillance system by guards is not provided at the Gold Shield Solvents facility.

F-1a(2)(a) Barrier [40 CFR §264.14(b)(2)(i)]

The entire hazardous waste container storage area is located within an enclosed building. This building is supplied with security doors which are locked at all times when the facility is unattended. The security precautions prevent the entry of unauthorized persons or livestock into the active portion of the hazardous waste handling area. Security precautions are illustrated in Attachment F-1.

F-1a(2)(b) Means to Control Entry [40 CFR §264.14(b)(2)(ii)]

As described above, the entire hazardous waste handling area is contained within a single building. The entrances to the building are controlled by security doors which are kept locked when the facility is unattended to prevent access to the active portions of the facility at all times to all except authorized persons.

F-1a(3) Warning Signs [40 CFR §264.14(c)]

Warning signs are posted on the outside wall of the building wherever an access door is located. The signs are legible from 25 feet and have one-inch high block letters with the following wording:

"Danger - Unauthorized Personnel Keep Out."

F-1b Waiver [40 CFR §264.14(a)]

Detrex Corporation does not request a waiver from the requirements of 40 CFR §264.14(a)(1) and (2).

F-2 INSPECTION SCHEDULE [40 CFR §270.14(b)(5),§264.15, 264.174, 264.195]

F-2a General Inspection Requirements [40 CFR §270.14(b)(5), §264.15(a) and (b), §264.33]

Gold Shield Solvents conducts regular inspections of the hazardous waste container storage area for leaking containers and for deterioration of containers and the containment system that could cause or lead to the release of hazardous waste constituents to the environment or threaten human health.

The hazardous waste container storage area is contained within a single 'warehouse' type building. This allows an almost continual check by on-site staff and rapid detection and response to any problems.

F-2a(1) Types of Problems [40 CFR §264.15(b)(3)]

Attachment F-2 presents the typical schedule for inspecting security, emergency equipment, the hazardous waste container storage area and the secondary containment area. Types of problems normally encountered with each inspection item are included. Copies of the inspection schedule are kept on file at the facility at all times.

F-2a(2) Frequency of Inspection [40 CFR §264.15(b)(4)]

Attachment F-2 also includes the frequency of inspection for each item.

F-2a(3) Remedial Action [40 CFR §264.15(c)]

Inspections may reveal problems of three types. The first type of problem involves the need for non-emergency maintenance. In this situation, qualified personnel will take the necessary actions as soon as possible to preclude further damage and reduce the potential for emergency repairs. The inspector will note in the inspection log when such action should be taken and verify the status at the next regularly scheduled inspection.

The second type of problem involves a non-emergency release of hazardous waste that is discovered during inspection. In this situation, appropriate remedial action will be taken immediately and documented in the inspection log. At a minimum, daily inspections will be made until the remedial action is completed.

The third type of problem involves the discovery of a release or the potential for the release of hazardous constituents to the environment in sufficient quantities to constitute an emergency. If this occurs, the Contingency Plan (included as Section G of this operating license application) will be implemented. The Contingency Plan provides a detailed description of the remedial action appropriate for this situation.

F-2a(4) Inspection Log [40 CFR §264.15(d)]

Provided in Attachment F-3 are typical daily and weekly inspection records. These are completed by the inspector at the conclusion of each routine inspection. Each inspection record is kept on file in an inspection log for a minimum of three years.

F-3 PREPAREDNESS AND PREVENTION [40 CFR §270.14(b)(6)]

The applicant does not wish to request a waiver of the preparedness and prevention requirements under 40 CFR §264 Subpart C. Requirements of this Subpart are also addressed in the contingency plan found in Section G of this application.

Grand Rapids Fire Department (GRFD) and Police Officials are familiar with the hazardous waste management operation, and with the contingency plan for the facility. A copy of the contingency plan will be kept in the office at all times.

F-3a Equipment Requirements [40 CFR §270.14(b)(6), §264.32,]

F-3a(1) Internal and External Communications [40 CFR §264.32(a) and (b)]

There is a telephone located within the building, immediately adjacent to the container storage area. This telephone can be actuated as a public address (P.A.) system to warn employees of potential hazards and to alert local emergency response teams (e.g., fire, ambulance, police).

F-3a(2) Emergency Equipment [40 CFR §264.32(c)]

Attachment F-4 presents the location of all emergency and safety equipment within the Gold Shield Solvents facility. This equipment includes:

1) Absorbent Material
2) First-Aid Kit
3) Eye Wash Station
4) Self Contained Breathing Apparatus
5) Respirator
6) Fire Extinguishers
7) Telephone/PA

All emergency and safety equipment is routinely inspected and tested in accordance with the inspection schedule presented in Section F-2 to ensure its proper operation in time of emergency.

F-3a(3) Water for Fire Control
[40 CFR §264.32(d)]

Fire hydrants in the immediate vicinity of the facility were located on Attachment B-2 presented in Section B of this application. The closest hydrant is located aproximately 150 feet north-east of the facility along Ellsworth Avenue.

F-3b Aisle Space Requirement [40 CFR §264.35]

Adequate aisle space for inspection purposes is maintained in the hazardous waste container storage area. This allows detection of spill material and the unobstructed movement of personnel, fire protection equipment, and spill control equipment.

F-4 PREVENTIVE PROCEDURES, STRUCTURES AND EQUIPMENT [40 CFR §270.14(b)(8)]

F-4a Loading/Unloading Operations [40 CFR §270.14(b)(8)(i)]

Hazardous waste loading/unloading operations, associated with the container storage area, consists of internal forklift or hand drum truck movement of drums to and from the container storage area. Forklifts are equipped with a special drum handling attachment.

The loading/unloading of drummed hazardous wastes occurs at the loading/unloading dock internal to the building. The truck backs up off of Ellsworth Avenue down the depressed truck ramp. The drums are loaded/unloaded using a forklift with a drum handling attachment or hand drum trucks.

A sump located in the base of the ramp. The sump is connected to the storm sewer. During loading/unloading operations, the pipes connecting the sump to the storm sewer are plugged to prevent spilled material, if any, from entering the sewer.

All loading/unloading operations are conducted under the supervision of Gold Shield Solvents personnel and the area used for loading/unloading is inspected at the conclusion of loading/unloading operations to ensure no spillage has occurred.

F-4b Run-off Control [40 CFR §270.14(b)(8)(ii)]

The hazardous waste container storage area is located within an enclosed building. This prevents accumulation of run-on waters in the hazardous waste storage area. As presented in Section B of this operating license application, surface runoff is directed away from the building structure in all areas except the loading ramp. Water collected in the loading ramp drains to a sump that is connected to the storm sewer.

F-4c Water Supplies [40 CFR §270.14(b)(8)(iii)]

Groundwater contamination is prevented by eliminating the discharge of hazardous waste onto the unprotected ground. The hazardous waste container storage area is contained within an enclosed building structure provided with adequate secondary containment.

F-4d Equipment and Power Failure
[40 CFR §270.14(b)(8)(iv)]

In the event of a power failure, plant operations will stop. There is no electrically-powered equipment involved in the operation of the hazardous waste container storage area.

F-4e Personnel Protection Equipment
[40 CFR §270.14(b)(8)(v)]

The personnel protection equipment provided at the facility is described in Section F-3a. It is further described in the Contingency Plan located in Section G of this operating license application. The proper use of the appropriate equipment is explained during personnel training procedures as described in Section H.

F-5 PREVENTION OF REACTION OF IGNITABLE, REACTIVE, AND INCOMPATIBLE WASTES [40 CFR §270.14(b)(9)§264.17]

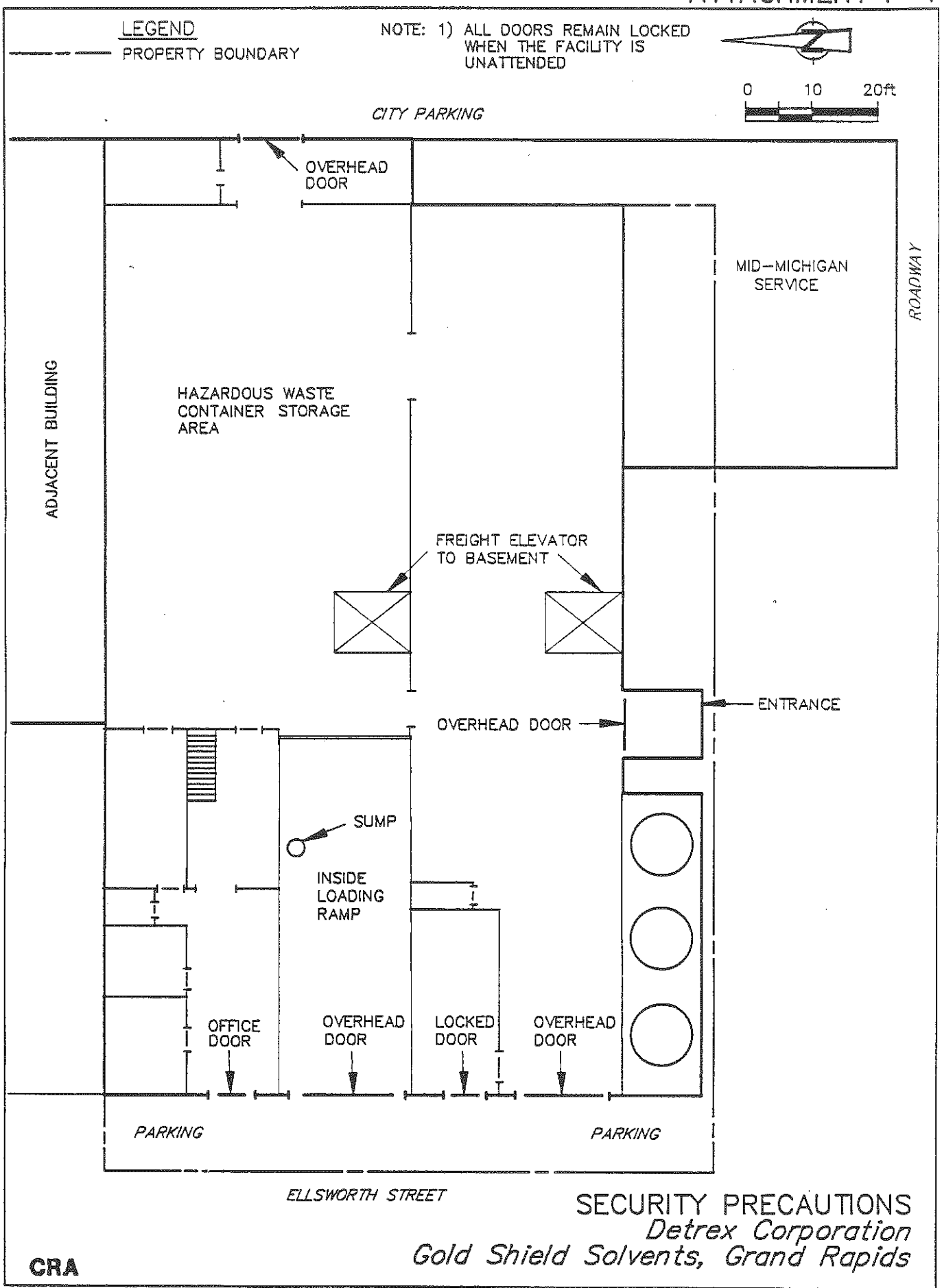
There are no ignitable, reactive or incompatible wastes stored in the container storage; hence, an operating license for the handling of ignitable, reactive, and incompatible wastes is not requested.

ATTACHMENT
F—1

ATTACHMENT F-1

SECURITY PRECAUTIONS

ATTACHMENT F-1



SECURITY PRECAUTIONS
Detrex Corporation
Gold Shield Solvents, Grand Rapids

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